DIABETES DATA

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FOREWORD

In 1964, a Diabetes Source Book (Public Health Service Publication No. 1168) was prepared under the supervision of Glen W. McDonald, M.D., then Chief of the Diabetes and Arthritis Control Program, U.S. Public Health Service. The book proved very useful to many individuals and agencies concerned with health problems, so, in response to popular demand, a revised edition containing new information was published in 1968. Diabetes Data Compiled 1977 is an outgrowth of that effort, but it is more than simply another revised edition of the popular Source Book. It is a compilation of facts ranging from clinical to economic, and includes prevalence and incidence statistics together with current concepts and information on federal initiatives to combat diabetes mellitus. Diabetes Data Compiled 1977 will be useful to persons responsible for guiding patients, to researchers, and to all those concerned with the public health aspects of diabetes.

The stimulus to prepare this book came from three sources: first, from the development of new data and concepts since the 1968 Source Book was published; second, from the efforts of the Committee on Scope and Impact of the National Commission on Diabetes, which resulted in an extensive updating, assembly, and discussion of data; and third, from the need for a current compilation of diabetes statistics for program planning by health agencies. The National Center for Health Statistics; the National Institute of Arthritis, Metabolism, and Digestive Diseases (NIAMDD); the American Diabetes Association; and the Juvenile Diabetes Foundation have each expressed an interest in this work.

The National Commission on Diabetes recognized the need for a systematic approach to the design, collection, analysis, and documentation of data to support a public health policy on diabetes and to provide a basis for evaluating the progress of the Commission's Long-Range Plan to Combat Diabetes. Accordingly, it recommended the establishment of a National Diabetes Data Group, located in NIAMDD, to foster the collection, analysis, and dissemination of diabetes data on a national basis. Diabetes Data Compiled 1976 is the National Diabetes Data Group's initial effort to make available current information. It was prepared under the combined efforts of the National Commission on Diabetes; the National Center for Health Statistics; the National Institute of Arthritis, Metabolism, and Digestive Diseases; and the American Diabetes Association.

Much of the information contained in this book was derived from the Report of the Committee on Scope and Impact of Diabetes to the National Commission. Additional data were obtained from published literature and unpublished information contributed by clinicians and researchers. Nationwide diabetes prevalence figures were obtained from household interview data collected by the National Center for Health Statistics.

We thank especially those who allowed us the use of their material, and the National Institute of Arthritis, Metabolism, and Digestive

Diseases for their encouragement and support of this publication. We also gratefully acknowledge the help and advice of Richard A. Christlieb, M.D., Max Ellenberg, M.D., Om Ganda, M.D., William B. Kannell, M.D., Christian R. Klimt, M.D., Dr. P.H., Genell Knatterud, Ph.D., Alexander M. Marble, M.D., John B. O'Sullivan, M.D., Pasquale J. Palumbo, M.D., Thaddeus E. Prout, M.D., Kelly West, M.D., Fred W. Whitehouse, M.D., and Donna Younger, M.D.

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DEFINITION AND DESCRIPTION

Diabetes is a disease of uncertain cause, characterized by chronic hyperglycemia and other disturbances of carbohydrate and lipid metabolism, and associated with the development of vascular complications. These complications may affect specific organs such as the eye (diabetic retinopathy), the kidney (diabetic nephropathy), or it may be associated with accelerated atherosclerosis resulting in increased frequency of coronary heart disease and peripheral vascular disease.

The classic symptoms of diabetes include increased thirst, hunger, excessive urination, itching, weight loss, and occasionally, dehydration and diabetic coma (diabetic ketoacidosis). However, in many persons the disease is asymptomatic. In such persons, the diagnosis may first be suspected by finding glucose in the urine. These suspicions may then be confirmed by finding elevated glucose levels in the blood, either after fasting or following the administration of a glucose load (abnormal glucose tolerance test).

In young persons, the onset of diabetes is often abrupt and associated with the classic signs and symptoms. Insulin therapy is almost always required to prevent or treat the development of diabetic acidosis in most juvenile-onset diabetics. In the majority of patients with diabetes, however, the disease appears at an older age, and most subjects with adult-onset diabetes, who as a rule do not require insulin and seldom develop ketoacidosis, nevertheless have the propensity to develop the associated vascular complications.

Sources and Limitations of Data

The prevalence and incidence data presented are those reported from the National Health Interview Surveys (HIS), conducted by the National Center for Health Statistics to obtain a health profile of the United States population. The recent data were gathered by interviewing a representative sample of households to obtain the health characteristics of each member of the household. In the 1973 HIS, data were collected on 120,000 persons from 40,000 households, 2,400 of whom were reported to have diabetes. These data were then weighted to make the sample representative of the total civilian, non-institutionalized population of the United States by age, sex, color, and residence.

The data are subject to three sources of error: first, possible under- or over-reporting of known diabetics; second, sampling variations; and third, the fact that subjects with undiagnosed diabetes cannot be identified by the interview method. The magnitude of the first source of error has not been determined, but it can reasonably be considered small compared to the likely degree of underestimation of the true disease rates caused by the omission of undiagnosed diabetes.

Prevalence of Diabetes

Prevalence is the frequency of a disease in the population at the time a survey is undertaken. Based on the 1973 HIS, the number of persons reporting diabetes in the United States is approximately 4.2 million, which is 2 percent of the total non-institutionalized civilian population (Table 1a, Figure 1). The rate increased with age from 1.3/1,000 (1 in 770) for persons under 17 years of age to 78.5/1,000 (1 in 12-13) among persons aged 65 years and over. Diabetes was reported 50 percent more frequently in females (2.57 million cases or 2.4 percent) than in males (1.6 million or 1.6 percent). The rates were higher in the non-white (2.4 percent) than in the white population (2.0 percent), and reached a level of 10.5 percent among non-whites aged 65 and over. Preliminary data from the 1975 Health Interview Survey indicate that the number of persons reporting diabetes in the United States is approximately 4.8 million (Table 1b).

Incidence of Diabetes

Incidence is the frequency of new cases of a disease developing during a specified time interval. During the 1973 HIS, persons reporting diabetes were asked to indicate the date the disorder was diagnosed. Based on this information, an estimated 612,000 persons or 0.3 percent of the U.S. population were diagnosed as diabetic during the preceding 12-month period (Table 2).

These data are subject to the same errors as the prevalence data and, in addition, may contain a bias of uncertain magnitude and direction relating to the accuracy of dating the diagnosis of the disorder.

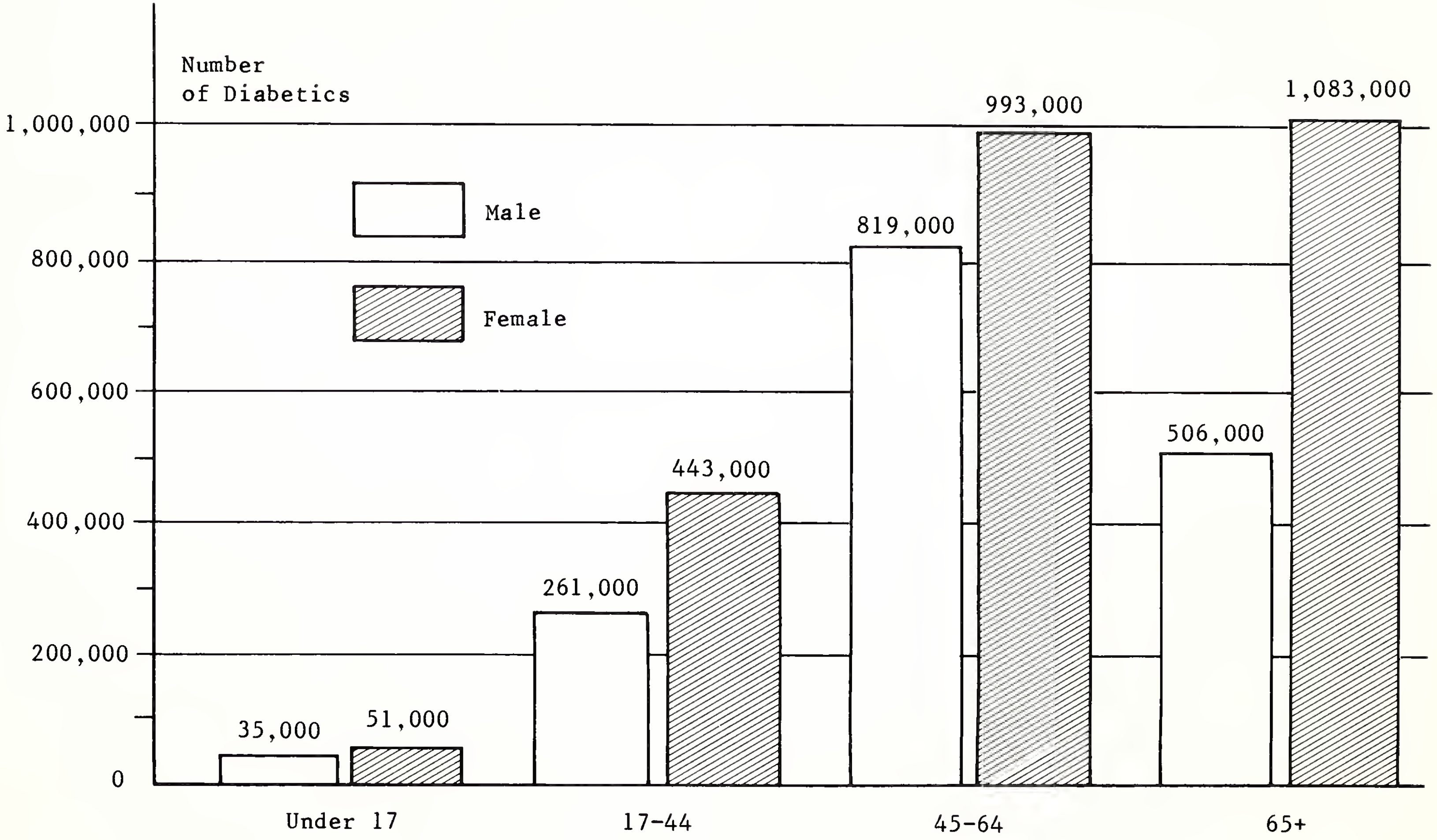
About 20,000 persons over 17 years of age reported developing diabetes during the one-year period. The incidence rates were greater in females than in males of corresponding age and increased with age in both sexes, reaching a maximum of 11.3/1,000 in females aged 65 and over.

TABLE 1a. REPORTED PREVALENCE OF DIABETES (WITH RATE PER 1000) BY AGE, SEX, AND RACE - UNITED STATES, 1973

			AGE							
	TOTAL		<17		17-44		45-64		65+	
	Number of Persons	Rate	Number of Persons	Rate	Number of Persons	Rate	Number of Persons	Rate	Number of Persons	Rate
TOTAL	4,191,000	20.4	86,000	1.3	704,000	8.9	1,813,000	42.5	1,589,000	78.5
Sex										
Male	1,620,000	16.3	35,000	1.1	261,000	6.9	819,000	40.6	506,000	60.3
Female	2,571,000	24.1	51,000	1.6	443,000	10.8	993,000	44.4	1,083,000	91.3
Race										
WHITE	3,570,000	19.9	74,000	1.4	576,00	8.3	1,518,000	39.6	1,402,000	75.9
OTHER	662,000	23.9	12,000	1.2	128,000	12.8	294,000	70.0	187,000	104.5

Source: 1973 Health Interview Survey data, National Center for Health Statistics.

FIGURE 1. REPORTED NUMBER OF DIABETICS BY AGE AND SEX, 1973



Source: 1973 Health Interview Survey data, National Center for Health Statistics.

TABLE 1b. REPORTED PREVALENCE OF DIABETES BY AGE AND SEX - UNITED STATES, 1975

	TOTAL	AGE			
		<17	17-44	45-64	65 +
	Number of Persons				
TOTAL	4,780,000	65,000	782,000	2,166,000	1,767,000
Male	2,028,000	37,000	325,000	983,000	684,000
Female	2,752,000	28,000	457,000	1,183,000	1,083,000

Source: 1975 Health Interview Survey unpublished data, National Center for Health Statistics.

TABLE 2. REPORTED ANNUAL INCIDENCE OF DIABETES (WITH RATE PER 1,000) BY AGE AND SEX - UNITED STATES, 1973

			AGE (Years)							
	TOTAL		<17		17-44		45-64		65+	
	Number of Persons	Rate	Number of Persons	Rate	Number of Persons	Rate	Number of Persons	Rate	Number of Persons	Rate
TOTAL	612,000	3.0	20,000	0.3	70,000	2.1	246,000	5.6	176,000	6.7
Males	215,000	2.2	8,000	0.3	57,000	1.5	109,000	5.4	41,000	4.9
Females	396,000	3.7	12,000	0.4	113,000	2.8	137,000	6.1	134,000	11.3

Source: 1973 Health Interview Survey data, National Center for Health Statistics.

The rates have not been presented by race because of the relatively small size of the non-white population sampled and the corresponding unreliability of the estimates.

Prevalence and Incidence by State and Region

Estimated prevalence and incidence data for diabetes for individual regions and states were derived by applying the national age-specific rates to the populations of the various states (Tables 3 and 4). Because they do not take into consideration variations due to racial, ethnic or cultural differences, these figures are at best gross approximations. Nevertheless, these estimates may be useful for local purposes. In the United States, 11 percent of the population is non-white; since the diabetes rate of this population is estimated to be 20 percent higher than that of the white population, the figures shown should be increased or decreased by 0.2 percent for every percent of a state's non-white population above or below 11 percent.

This method of estimation was used because the 1973 HIS prevalence estimates based on the sampling procedure designed to determine differences among geographic regions of the U.S. revealed only small variations in age-specific rates among the regions (Table 5).

Prevalence and Incidence by Reported Family Income

A marked inverse relationship between both the incidence and prevalence of reported diabetes and reported family income was found in the 1973 HIS (Table 6). The relationship appeared in each of the age groups except in the age group under 17 years where the data were insufficient to provide reliable estimates. The extent to which this relationship can be explained on the basis of the differences in diabetes rates between

TABLE 3. ESTIMATED NUMBER OF EXISTING CASES OF DIABETES BY AGE, REGION, AND STATE

	All Ages	<17	17-44	45-64	65+
NORTHEAST	1,075,000	19,500	159,800	468,600	427,000
Maine	22,400	400	3,300	9,100	9,600
New Hampshire	16,600	300	2,700	6,800	6,800
Vermont	9,500	200	1,600	3,700	4,000
Massachusetts	125,600	2,300	19,100	52,300	51,900
Rhode Island	21,000	400	3,000	8,900	8,700
Connecticut	65,100	1,200	10,200	29,100	24,600
New York	393,600	7,100	59,300	170,400	156,800
New Jersey	156,400	3,000	23,500	71,200	58,800
Pennsylvania	264,800	4,600	37,200	117,100	105,800
NORTH CENTRAL	1,179,900	24,300	189,300	493,800	472,600
Ohio	216,500	4,500	35,600	94,000	82,400
Indiana	105,900	2,300	17,800	44,900	41,000
Illinois	229,100	4,600	36,600	98,800	89,000
Michigan	173,600	4,000	30,600	76,300	62,600
Wisconsin	94,800	1,900	14,800	38,400	39,600
Minnesota	79,900	1,700	12,900	31,400	33,900
Iowa	63,200	1,200	8,900	24,800	28,300
Missouri	105,200	1,900	15,400	41,500	46,400
North Dakota	13,300	300	2,000	5,400	5,700
South Dakota	14,900	300	2,100	5,900	6,600
Nebraska	33,500	600	5,000	12,900	15,000
Kansas	50,000	900	7,500	19,600	22,100
SOUTH	1,360,600	28,300	224,700	566,500	541,100
Delaware	10,900	200	2,000	4,900	3,800
Maryland	77,600	1,700	14,300	35,400	26,100
Washington, D.C.	14,600	300	2,700	6,100	5,600
Virginia	93,300	2,000	17,500	41,600	32,200
West Virginia	39,600	700	5,600	17,100	16,200
North Carolina	103,400	2,200	18,700	45,300	37,100
South Carolina	50,400	1,200	9,700	22,200	17,200
Georgia	90,300	2,100	17,000	38,800	32,400
Florida	201,700	3,000	24,400	74,800	99,500
Kentucky	69,300	1,400	11,000	28,300	28,600
Tennessee	84,900	1,700	13,900	35,600	33,700
Alabama	72,100	1,500	11,700	30,200	28,700
Mississippi	45,800	1,100	7,300	18,100	19,300
Arkansas	45,900	900	6,400	17,900	20,700
Louisiana	70,300	1,700	12,400	29,700	26,500
Oklahoma	59,300	1,100	8,900	23,600	25,700
Texas	231,300	5,200	41,100	97,000	87,900

TABLE 3. ESTIMATED NUMBER OF EXISTING CASES OF DIABETES BY AGE, REGION, AND STATE (Continued)

	All Ages	<17	17-44	45-64	65+
WEST	733,100	15,400	129,300	316,600	271,800
Montana	14,800	300	2,400	6,400	5,700
Idaho	15,600	400	2,600	6,700	6,000
Wyoming	7,000	200	1,200	3,200	2,500
Colorado	45,800	1,100	9,100	19,600	16,000
New Mexico	19,700	500	3,800	8,600	6,800
Arizona	42,300	1,000	7,100	17,700	16,600
Utah	19,700	600	4,000	8,200	6,900
Nevada	10,600	200	2,000	5,200	3,200
Washington	70,700	1,400	11,900	29,500	27,800
Oregon	48,400	900	7,500	20,300	19,700
California	419,800	8,300	73,300	182,300	155,900
Alaska	4,200	200	1,400	2,000	600
Hawaii	14,500	400	3,100	6,900	4,200

Source: 1973 Health Interview Survey data, National Center for Health Statistics, computed on the basis of national age-specific prevalence rates and rounded to nearest 100 cases.

TABLE 4. ESTIMATED ANNUAL NUMBER OF NEW CASES OF DIABETES BY AGE, REGION, AND STATE, 1974

	All Ages	<17	17-44	45-64	65+
NORTHEAST	154,083	4,770	38,475	63,607	47,231
Maine	3,199	111	792	1,237	1,059
New Hampshire	2,397	83	648	919	747
Vermont	1,334	50	332	509	443
Massachusetts	17,997	561	4,597	7,100	5,739
Rhode Island	2,980	90	712	1,214	964
Connecticut	9,423	301	2,453	3,943	2,726
New York	56,505	1,727	14,303	23,128	17,347
New Jersey	22,548	720	5,663	9,662	6,503
Pennsylvania	37,700	1,127	8,975	15,895	11,703
NORTH CENTRAL	170,898	5,970	45,647	67,018	52,263
Ohio	31,560	1,103	8,586	12,755	9,116
Indiana	15,525	613	4,292	6,088	4,532
Illinois	33,216	1,128	8,835	13,408	9,845
Michigan	25,641	972	7,380	10,361	6,928
Wisconsin	13,638	475	3,569	5,210	4,383
Minnesota	11,541	410	3,120	4,261	3,750
Iowa	8,934	287	2,157	3,365	3,125
Missouri	14,953	469	3,721	5,632	5,131
North Dakota	1,911	67	485	734	625
South Dakota	2,102	71	504	798	729
Nebraska	4,764	156	1,198	1,752	1,658
Kansas	7,113	219	1,800	2,654	2,440
SOUTH	196,854	6,889	54,180	76,893	58,892
Delaware	1,615	60	479	659	417
Maryland	11,566	419	3,451	4,805	2,891
Washington, D.C.	2,158	65	650	827	616
Virginia	13,914	494	4,217	5,643	3,560
West Virginia	5,636	176	1,348	2,324	1,788
North Carolina	15,314	546	4,515	6,146	4,107
South Carolina	7,566	301	2,346	3,018	1,901
Georgia	13,462	524	4,090	5,262	3,586
Florida	27,774	736	5,891	10,147	11,000
Kentucky	10,003	345	2,659	3,839	3,160
Tennessee	12,324	412	3,354	4,834	3,724
Alabama	10,470	376	2,820	4,105	3,169
Mississippi	6,619	263	1,764	2,457	2,135
Arkansas	6,472	209	1,543	2,428	2,292
Louisiana	10,367	423	2,994	4,024	2,926
Oklahoma	7,507	262	2,140	3,209	1,896
Texas	34,087	1,278	9,919	13,166	9,724

TABLE 4. ESTIMATED ANNUAL NUMBER OF NEW CASES OF DIABETES BY AGE, REGION, AND STATE, 1974 (Continued)

	All Ages	<17	17-44	45-64	65+
WEST	107,950	3,746	31,172	42,967	30,065
Montana	2,153	77	569	873	634
Idaho	2,282	87	622	914	660
Wyoming	1,032	38	288	428	278
Colorado	6,882	256	2,195	2,660	1,771
New Mexico	2,953	130	908	1,168	747
Arizona	6,172	231	1,704	2,405	1,832
Utah	2,984	140	964	1,116	764
Nevada	1,595	60	479	700	356
Washington	10,303	345	2,878	4,007	3,073
Oregon	6,970	219	1,820	2,752	2,179
California	61,682	2,033	17,666	24,741	17,242
Alaska	708	41	326	272	69
Hawaii	2,233	89	753	931	460

Source: 1973 Health Interview Survey data, National Center for Health Statistics, computed on the basis of national age-specific incidence rates.

TABLE 5. PREVALENCE OF DIABETES BY GEOGRAPHIC REGION--UNITED STATES, 1973

	NUMBER OF DIABETICS (IN THOUSANDS)					RATES/1,000 PERSONS				
Geographic Region	All Ages	<17	17-44	45-64	65+	All Ages	<17	17-44	45-64	65+
Northeast	984	*	154	425	384	20.2	*	8.4	39.6	74.9
North Central	1,187	*	199	505	456	21.1	*	9.3	43.5	79.9
South	1,355	*	199	617	521	20.8	*	7.9	47.2	83.5
West	665	*	151	266	228	18.7	*	10.6	37.4	71.8

*Data insufficient to provide satisfactory estimate.

Source: 1973 Health Interview Survey data, National Center for Health Statistics.

TABLE 6. ANNUAL INCIDENCE AND PREVALENCE RATES (PER 1,000) OF DIABETES BY REPORTED FAMILY INCOME -- UNITED STATES, 1973

Reported Family Income	Incidence	Prevalence
TOTAL	3.0	20.4
Less than $5,000	4.5	40.2
$5,000 - $9,999	3.4	20.0
$10,000 or More	2.2	13.7

Source: Computed from 1973 Health Interview Survey data, National Center for Health Statistics.

the racial groups remains to be determined. The relationship, however, is an important one since there was a three-fold difference in prevalence and a two-fold difference in incidence between the lowest and the highest reported income groups.

Changes in Prevalence and Incidence

Table 7 indicates changes in the reported prevalence of diabetes in the United States between 1965-66 and 1973. During this time, the estimated number of diabetics increased from 2,772,000 to 4,191,000 persons, a 51 percent increase in the number of cases. The overall prevalence rate has increased from 14.5/1,000 to 20.4/1,000 persons, an increase of approximately 40 percent. The rates increased 50 percent for females (from 16.1/1,000 to 24.1/1,000), and by 26 percent for males (from 12.9/1,000 to 16.3/1,000). While increases occurred in all age groups, they

TABLE 7. CHANGES IN PREVALENCE OF REPORTED DIABETES BETWEEN 1965/66 AND 1973 HEALTH INTERVIEW SURVEY -- UNITED STATES

	Rates per 1,000 persons 1965/66	1973	Percentage Change
All Persons	14.5	20.4	+41%
Males			
All Ages	12.9	16.3	+26%
<45	3.7	4.3	+16%
45-64	29.6	40.6	+37%
65+	51.4	60.3	+17%
Females			
All Ages	16.1	24.1	+50%
<45	3.8	6.8	+79%
45-64	31.0	44.4	+43%
65+	70.5	91.3	+29%

Source: Health Interview Survey 1965/66 and 1973, National Center for Health Statistics.

are especially notable among middle-aged males and females under 45 years of age.

Table 8 shows a comparison of changes in prevalence rates by age and race between 1965 and 1973. While there have been major increases in the frequency of reported diabetes in both whites and non-whites, the increase of diabetes in non-whites under 45 years of age is most striking.

TABLE 8. CHANGES IN PREVALENCE OF REPORTED DIABETES BETWEEN 1964/65 AND 1973 HEALTH INTERVIEW SURVEY -- UNITED STATES

	Rates per 1,000 persons 1964/65	1973	Percentage Change
White			
All Ages	12.1	19.9	+64%
<45	3.0	5.3	+77%
45+	32.8	51.4	+57%
Non-white			
All Ages	13.3	23.9	+80%
<45	2.8	7.0	+150%
45+	50.2	80.3	+60%

Source: Health Interview Survey 1964/65 and 1973, National Center for Health Statistics.

It is also notable that the annual incidence of reported diabetes has also increased over the same time period (Table 7). In 1965, an estimated 325,000 persons reported that they had been diagnosed as diabetic in the previous 12 months, whereas an estimated 612,000 persons reported a diagnosis of diabetes in 1973. Detailed tabulations of incidence rates for HIS surveys prior to 1973 are not available at present, so it is not yet possible to determine which subgroups of the population have shown the greatest changes.

Many questions remain unanswered concerning the significance of the changes in prevalence and incidence of diabetes. The changes may reflect a true increase in the frequency of diabetes. If so, the rate of increase in incidence (and prevalence) is most alarming. Alternatively, the increases may represent an increase in the recognition of diabetics, who in earlier surveys, e.g., in 1965, would have been undiagnosed. There is circumstantial evidence that this is likely, since in the past decade the rapid expansion of automated blood chemistry has resulted in many more persons receiving glucose determinations at more frequent intervals than in the past. Whether this phenomenon can account for all or for only a part of the reported increases can only be determined by examination of an appropriate sample of the U.S. population by glucose tolerance testing to determine whether or not the proportion of the population with undiagnosed diabetes has diminished to a degree proportionate to the increase in diagnosed diabetes.

Undiagnosed Diabetes

Systematic examination of glucose tolerance in a probability sample of the U.S. population was performed during the National Health Examination Survey 1960-62 in persons aged 18-79 years. In this survey, 1.8 percent had a previous diagnosis of diabetes, indicating that approximately 2 million persons in the U.S. had diabetes in 1960-62. Among the remainder, 3.9 percent (an estimated 4,277,000 persons in the U.S.) had a one-hour blood glucose level of 200 mg/100 ml or over following a 50 gm oral glucose load. Although there is considerable debate about criteria for the interpretation of the glucose tolerance test, most of these undiagnosed persons can conservatively be considered as likely to have diabetes.

Whether or not the proportion with undiagnosed diabetes has diminished while the proportion with diagnosed diabetes has increased since 1960-62 will be determined during the 1975-77 National Health Examination Survey.

Other Etiological Factors

Heredity. The inherited predisposition to diabetes has been established by twin studies, by associations with other inherited characteristics such as histocompatibility antigens, and is further suggested by the increased incidence of diabetes in relatives of diabetics compared to nonrelatives. However, it also seems certain that diabetes is a heterogenous disease and that the insulin-dependent, juvenile onset form may have different genetic determinants than the insulin-independent type. The mode of inheritance, however, has not been established for any type of diabetes. Without this knowledge, it is impossible to predict who will carry the genetic predisposition to diabetes, except for the identical twin of a diabetic. Empirical risks, however, have been determined in Canada. These predictions are reproduced in Table 9.

Obesity. Obesity is the factor with the strongest relationship to the risk of developing diabetes. Figure 2 shows a strong relationship between obesity and incidence of diabetes in men. Incidence rates in very obese men were more than 20 times greater than in the non-obese. It is also of considerable interest that incidence rates were exceedingly low in the lean subjects.

Remarkably little information is available on the magnitude of this association in the United States population, since height and weight were

TABLE 9a. INCREASED RISK FOR DIABETES AMONG LIVING PARENTS OF DIABETICS COMPARED TO RISK FOR CONTROLS

PROBAND	FATHERS				MOTHERS			
	Age of Onset	Number	%	Increased risk for parents compared to controls*	Age of Onset	Number	%	Increased risk for parents compared to controls*
Sex								
Male	0-19	879	2.7	x2	0-19	909	0.9	x2
	20-39	355	5.1	x2	20-39	456	7.7	x2
	>40	155	14.8	x4	>40	277	14.4	x3
Female	0-19	987	3.3	x3	0-19	1,045	2.3	x2
	20-39	355	7.6	x3	20-39	431	7.4	x2
	>40	152	8.6	x3	>40	257	9.7	x2
Total:		2,883	4.8			3,378	4.8	

TABLE 9b. INCREASED RISK FOR DIABETES AMONG LIVING SIBS OF DIABETICS COMPARED TO RISK FOR CONTROLS

PROBAND	BROTHERS				SISTERS			
	Age of Onset	Number	%	Increased risk for sibs compared to controls*	Age of Onset	Number	%	Increased risk for sibs compared to controls*
Male	0-19	1,236	2.5	x14	0-19	1,142	1.8	x10
	20-39	995	4.0	x 5	20-39	982	3.4	x 4
	>40	1,820	8.0	x 4	>40	1,935	5.0	x 2
Female	0-19	1,382	2.2	x11	0-19	1,308	3.1	x13
	20-39	1,125	3.2	x 4	20-39	1,107	4.2	x 4
	>40	2,272	7.1	x 3	>40	2,518	6.8	x 2
Total:		8,830	5.1			8,992	4.5	

TABLE 9c. INCREASED RISK FOR DIABETES AMONG LIVING CHILDREN OF DIABETICS COMPARED TO RISK FOR CONTROLS

PROBAND	SONS				DAUGHTERS			
	Age of Onset	Number	%	Increased risk for children compared to controls*	Age of Onset	Number	%	Increased risk for children compared to controls*
Male	0-19	116	2.6	x40	0-19	118	2.5	x41
	20-39	662	1.5	x13	20-39	657	0.6	x 7
	>40	1,479	0.7	x 3	>40	1,400	0.9	x 2
Female	0-19	145	1.4	x29	0-19	175	1.1	x18
	20-39	614	0.7	x 6	20-39	646	1.2	x 9
	>40	2,146	1.4	x 3	>40	2,149	0.7	x 1
Total:		5,162	1.1			5,145	0.9	

*This value is a weighted mean of the proportion of diabetes in relatives/proportion in control by sex for each decade of birth.

Source: Simpson, N. The Canadian Medical Association Journal, 98:427-32, 1968.

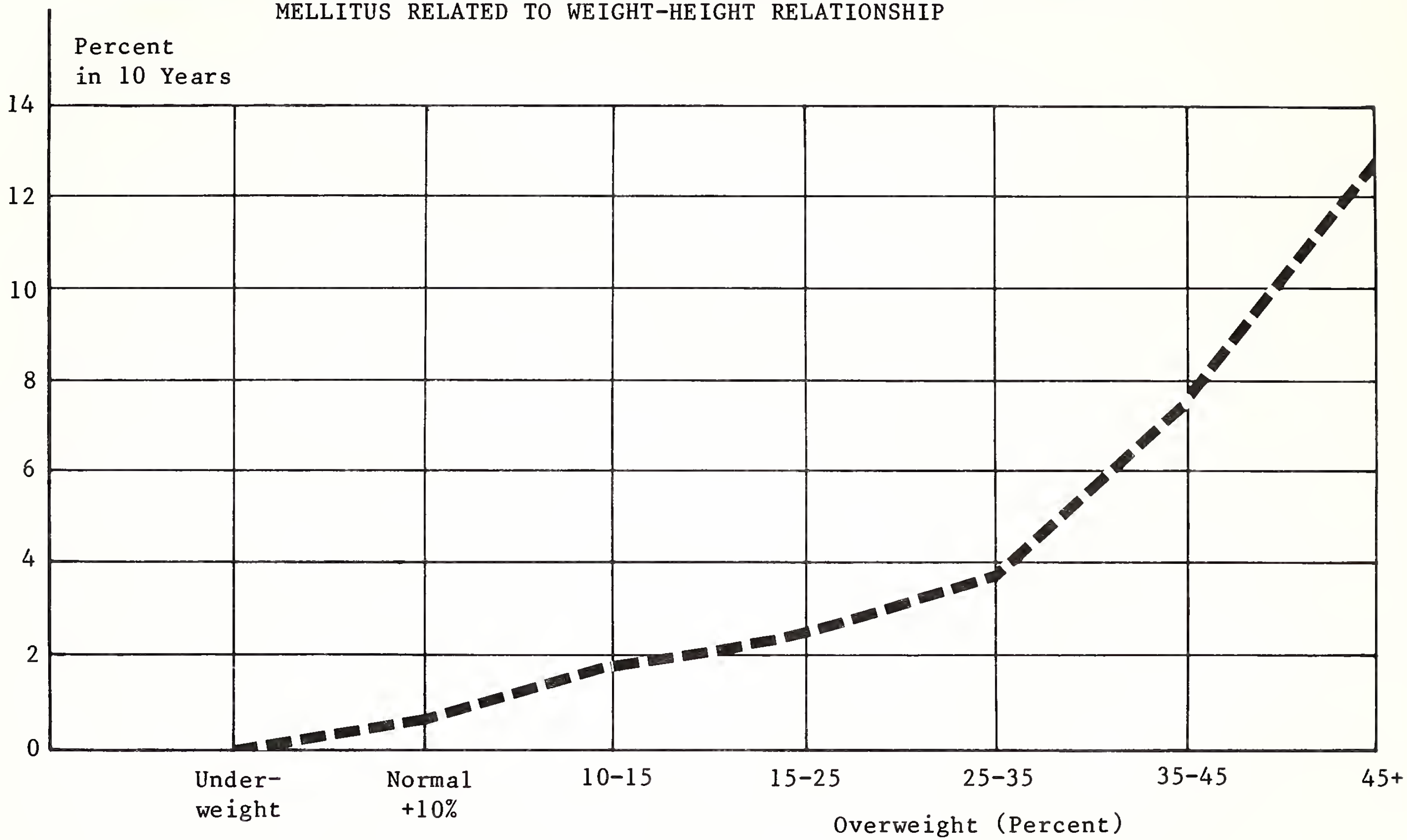


FIGURE 2. AGE-ADJUSTED 10-YEAR INCIDENCE OF FIRST DIAGNOSIS OF DIABETES MELLITUS RELATED TO WEIGHT-HEIGHT RELATIONSHIP

Source: Data of Westlund -- 3,751 Men of Oslo Age 40-49 Initially.
(Scand. J. of Clin. and Lab. Invest., v. 30, Suppl. 127, p. 21)

not measured during the interview surveys in which diabetes data were obtained. The prevalence of obesity in the adult population of the U.S. has been determined and shows variation with age and racial origin, with black females having the greatest frequency, and females of either racial group showing more obesity than the males of the same age and racial group (Table 10). It is tempting to speculate that the excessive diabetes rates among non-white women may be at least in part explained by the higher prevalence of obesity in this group.

TABLE 10. PERCENT OF OBESE INDIVIDUALS IN THE UNITED STATES, 1971-72, BY AGE, RACE, AND SEX

	Age	
Race and	20-44	45-74
TOTAL	17.6	19.6
White Males	16.0	13.4
White Females	18.9	24.7
Black Males	10.6	7.7
Black Females	29.2	32.4

Source: 1971-72 Health and Nutrition Examination Survey, National Center for Health Statistics

MORBIDITY OF LONG- AND SHORT-TERM COMPLICATIONS

Despite the increasing interest in diabetes in recent years, only limited data on the prevalence and incidence of long- and short-term complications are available. There have been numerous surveys of vascular disease in clinic populations of diabetics, but it is difficult to compare the findings because of sampling variations between clinics and lack of uniformity of measurements. In regard to large collections of observations, the Framingham, Massachusetts, and the Tecumseh, Michigan, surveys of total populations have provided statistics. Also, the University Group Diabetes Program has developed data on the frequency of complications in the middle-aged stable-type diabetic at the time of diagnosis of diabetes, with cumulative estimates of events over the following years. Other studies have yielded additional helpful information and can be found in the references. In juvenile diabetes, most reports have dealt with prevalences of events at a given point of time with little attention given to incidences or rates of development of events over given periods of time.

The vascular events receiving the most attention have been those of coronary heart disease, peripheral vascular disease, and small vessel disease of the eyes and kidney. There are reports on the occurrence of hypertension, but little has been published on cerebrovascular accidents. Finally, the frequency of neuropathy is not well documented.

In regard to short-term complications, acidosis continues to occur despite prevention efforts. Unfortunately, very little data on the occurrence of infections are at hand. Finally, brief surveys of the frequency of complications and of the outcome of pregnancy and diabetes are given in the succeeding pages. Also, the relation of gestational diabetes to later development of permanent diabetes is discussed. In this report, the data given are from the United States except where lack of information makes it necessary to use data from other countries.

Coronary Heart Disease

General

Coronary heart disease is very common in diabetes and is a major cause of death. Other heart diseases found among diabetics are enlargement of the heart resulting from high blood pressure, and possible small blood vessel disease. Coronary heart disease may occur in all diabetics, but the majority of cases comes from the adult-onset diabetic population. Coronary heart disease may develop in the juvenile-onset population when diabetes is long-standing or when renal failure has set in.

Statistics

Coronary heart disease accounts for about 700,000 deaths yearly, one-third of deaths from all causes (1). About 20 percent of all patients with coronary heart disease have associated hyperglycemia (1). Twenty-five percent of known diabetics (about one million persons) are under treatment for heart disease (1).

Prevalence. Reports of prevalences of coronary heart disease at autopsy have ranged from 18 to 75 percent in diabetics compared to 8 to 37 percent in non-diabetics, the ratio being about 2:1 in most of the reports (2).

In clinic surveys of living adult diabetic patients with varying ages and durations of diabetes, coronary heart disease was found in frequencies of 26 to 42 percent in contrast to 1.6 and 4.1 percent in the population at large. At the time of diagnosis of maturity-onset diabetes, prevalences of 9.5 percent in the University Group Diabetes Program (3) and 20 percent in a Rochester, Minnesota, population were observed (4). It has been suggested that diabetic women are more at risk for coronary heart disease than are diabetic men.

Incidence. Two hundred thirty-nine diabetics in the Framingham, Massachusetts, study were followed for 16 years (5). At the end of this time, 17 percent of those free of heart disease at the beginning of the study had developed heart disease, in contrast to 9 percent in the entire population. Cardiovascular deaths similarly were increased to 18 percent in the diabetics compared to 6 percent in the whole population during the same period. In the University Group Diabetes Program, after a median observation time of 6.5 years, researchers noted a 12 percent incidence of new myocardial infarctions and a mortality of 4.4 percent in newly diagnosed adult-onset diabetics (6). In a similar type of population in Rochester, Minnesota (4), there was a 34 percent incidence of new coronary heart disease over a median period of observation of 7.5 years, with a death rate from all causes of 24 percent. Coronary heart disease was the cause of death or contributed to it in 52 percent of losses in the follow-up of these patients. In England, 13 percent of newly diagnosed diabetics developed myocardial infarction in six years (7).

Course. In studies of survival after an initial attack of myocardial infarction, immediate mortality rates of 31 to 58 percent have been reported. Total survival, including that of the initial and subsequent attacks, was 19, 24, and 29 percent. In comparison, total survivorship in groups comprised mainly of non-diabetic men have been more than 50 percent, on the average.

TABLE 11. REPORTS OF PREVALENCES OF CORONARY HEART DISEASE IN GROUPS OF LIVING DIABETIC PATIENTS AND IN GENERAL POPULATIONS

Location	Patient Population	Pathology	Age	Number	Percent	Reference
Cleveland 1955	general diabetic	CHD	10-90	383	42	(8)
		MI			6.8	
		AP			10	
Boston 1957	adult diabetic	CHD	40+	288	26	(9)
		MI			11	
		AP			12	
Nashville 1961	black diabetic	CHD	23-88	100	33	(10)
Cleveland 1964	adult diabetic women	CHD	40-70	58	33	(11)
United States 1965	juvenile diabetic	HD	15+	442	5.4	(12)
United States 1970*	adult diabetic	CHD	20-79	1006	9.5	(3)
Rochester, Minn.* 1976	adult diabetic	CHD	30+	1028	20	(4)
Framingham, Mass. 1961	general population	CHD	30-62	5209	1.6	(13)
Tecumseh, Mich. 1965	general population	CHD	16-70+	5129	4.1	(14)

CHD - coronary heart disease
MI - myocardial infarction
AP - angina pectoris
HD - heart disease

*CHD at time of diabetes diagnosis

TABLE 12. REPORTED MORTALITY OF DIABETICS WITH FIRST ATTACK OF MYOCARDIAL INFARCTION

Location	Patient Population	Number Patients	Immediate Mortality (%)	Number Patients	Late Mortality (5 yrs. %)	Total Survival* (%)	Reference
Philadelphia 1952	diabetic	39	31				(15)
Chicago 1954	diabetic	63	33	42	57	29	(16)
Boston 1956	diabetic	83	58	35	81	19	(17)
Boston 1965	diabetic	205	38	127	62	24	(18)
Chicago 1954	general	461	23	285	33	52	(16)
Rochester, Minn. 1960	general	279	16	168	45	46	(19)
Detroit 1961	railroad workers			202	17		(20)
Wilmington, Delaware 1964	industrial employees	1,331	30	932	26	52	(21)
Little Rock 1960	veterans	503	15	427	31	59	(22)

*Survivorship after immediate and late losses.

Peripheral Vascular Disease

General

Peripheral vascular disease (arteriosclerosis of the peripheral arteries) is common in diabetes, particularly in older patients with onset of diabetes. Impairment of the circulation leading to gangrene and amputation may occur. The juvenile diabetic, instead, tends to have calcium in the walls of his peripheral arteries without circulatory impairment.

Statistics

Prevalence. Occlusive peripheral vascular disease in the diabetic has been reported in living diabetic groups in ranges of 16 to 58 percent, and gangrene at autopsy has been reported in 13 and 29 percent. Gangrene on death certificates is about 20 times more common in the diabetic than in the non-diabetic population (23). Non-occlusive calcification of peripheral arteries in juvenile diabetics has been observed in 85 percent of cases with duration of known diabetes 20 or more years (24).

Incidence. Diabetic patients of the maturity-onset type in the University Group Diabetes Program who had no intermittent claudication or amputation at the time of diagnosis of diabetes had 11.3 percent and 0.4 percent incidences of these two events, respectively, after a median time of 6.5 years (6). In a similar population in Rochester, Minnesota, the incidence of new peripheral vascular disease over a median period of 7.5 years observation was 16 percent (4). At 16 years duration of known diabetes, 8.8 percent of diabetics in the Framingham study developed claudication in contrast to 2.0 percent of controls (5). In studies of amputees

TABLE 13. REPORTS OF PREVALENCES OF PERIPHERAL VASCULAR DISEASE IN DIABETES

Location	Patient Population	Pathology	Age	Number	Percent	Reference
Minneapolis 1952	diabetic autopsy	gangrene	30-91	1,470	13	(27)
New Jersey 1953	general diabetic	physical signs, X-ray calcification	17-64	264	58	(28)
Boston 1956	juvenile diabetic	X-ray calcification	20-49	835	85	(24)
Boston 1957	general diabetic	signs, claudication	<10->80	394	16	(9)
Philadelphia 1958	general diabetic	calcification signs, tests	<19->80	1,600	54	(29)
Boston 1960	diabetic autopsy	gangrene		1,854	29	(30)
United States 1970	adult diabetic[1]	X-ray calcification	20-79	997	16	(3)
Rochester, Minnesota 1976	adult diabetic[2]	signs	30+	1,028	8.4	(4)

[1] At diagnosis of diabetes, right lower limb.

[2] At diagnosis of diabetes.

in New York, there was an incidence of 67 percent of lesions in the remaining leg in five years time (25). In studies in Detroit, the proportion of surviving amputees was only 50 percent at three years, indicating that the risk of death may be greater than the risk of losing the second leg (26).

Hypertension

General

Hypertension in the diabetic population may be tentatively classified as 1) essential hypertension, hypertension of unclear etiology prevalent in the non-diabetic population; 2) systolic hypertension, hypertension secondary to major arterial atherosclerosis; and 3) diabetic hypertension, a form of renal hypertension etiologically related to the renal disease of diabetes. Surgically curable forms of hypertension are encountered no more frequently in diabetics than in non-diabetics. Accelerated hypertension in diabetes occurs rarely.

Statistics

Approximately 23 million people in the United States with or without diabetes have hypertensive heart disease (31). Of these, over 20,000 die yearly from the effects of high blood pressure (31).

Prevalence. The frequencies of hypertension at a given time in diabetic populations have been reported as ranging from 8 to 65 percent, depending on age ranges regardless of diabetes duration. Interpretation of these surveys may be difficult, however. Several do not differentiate between juvenile and maturity-onset diabetes. Moreover, definitions of hypertension are not always uniform among the studies, nor were methods of blood pressure determinations always standardized. In the University Group Diabetes Program, dealing with maturity-onset diabetics, hypertension was found in 31 percent of middle-aged stable-type diabetics at the time of diagnosis of diabetes (3).

Incidence. In studies of subgroups of diabetics, it has been reported that surviving juvenile diabetics after 35 years duration of diabetes have a frequency of over 50 percent of hypertension (24). When proteinuria develops in diabetes, over 30 percent of patients will have hypertension; and when renal failure develops, over 90 percent of patients will have hypertension (32). Forty-three percent of maturity-onset diabetics in the University Group Diabetes Program with normal blood pressure at the time of diagnosis of diabetes had hypertension after a median period of 6.5 years (6).

Retinopathy

General

Visual impairment and blindness are risks faced by the diabetic. They are more likely to afflict the younger diabetic population, though older diabetics are not exempt. Benign or background retinopathy rarely interferes with vision. Neovascularization, or new vessel formation, leads to hemorrhage, scarring, and visual loss. It is generally held that glaucoma occurs beyond the expected.

TABLE 14. REPORTS OF PREVALENCE OF HYPERTENSION IN DIABETES MELLITUS

Location	Patient Population	Age	Number	Percent	Reference
Minneapolis 1953	autopsied diabetic	20-50	157	45	(33)
		51-90	971	65	
		all	1,128	62	
Cleveland 1955	general diabetic	10-90	383	43	(8)
Boston 1956	juvenile diabetic				(24)
	duration 20-24 yrs.	20-56	272	32	
	duration 30-34 yrs.		211	53	
Boston 1957	general diabetic	<40	106	8	(9)
		≥40	288	36	
		all	394	28	
Nashville 1961	black diabetic	23-88	100	59	(10)
Wilmington, Delaware, 1967	industrial employees diabetic men	45-64	615	36	(34)
United States 1970	adult diabetic*	20-79	1,007	31	(3)
Rochester, Minnesota 1976	adult diabetic*	30+	1,013	30	(4)

*Hypertension at time of diagnosis of diabetes.

TABLE 15. REPORTED PREVALENCES OF RETINOPATHY

Source	Patient Population	Duration of Known Diabetes (yrs)	Number	Percent	Reference
Boston 1956	juvenile diabetic	20 yrs	879	59	(24)
Cincinnati 1971	juvenile diabetic	20 yrs	167	45	(38)
Boston 1957	general diabetic	all durations	370	38	(9)
Oxford, Eng. 1968	general diabetic	all durations	2,184[1]	38	(36)
United States 1970	adult diabetic[2]	<1 yr	716	16	(3)

[1] 3,907 observations on 2,184 patients.

[2] Right central fundus photo. Retinopathy includes capillary, venous and arterial pathology excluding exudates.

TABLE 16. REPORTED PREVALENCES OF NEOVASCULARIZATION

Source	Patient Population	Duration of Known Diabetes (yrs)	Number	Percent	Reference
Boston 1956	juvenile diabetic	0-9	879	0	(24)
		15-19		18	
		25-29		46	
		30-34		59	
Cincinnati 1971	juvenile diabetic	20	167	27	(38)
		25		40	
		30		46	
United States 1976	adult diabetic	6.5[1]	602	0.7[2]	(6)
Oxford, Eng. 1968	age at diagnosis <30	0-29		0-14	(36)
	age at diagnosis 30-59	0-29		1-10	

[1] Median duration of known diabetes.

[2] Right central fundus photo.

Statistics

Blindness is 25 times more common in the diabetic than in the non-diabetic population (35), and each year, about 5,000 diabetics become blind (35).

Prevalence. In juvenile diabetics with diabetes known for 10 years or more, reported prevalences of retinopathy have ranged from 19 to 100 percent (12). In general diabetic populations, two surveys disclosed a frequency of 38 percent each (9, 36). In the University Group Diabetes Program, at least 16 percent of middle-aged stable-type diabetics had retinal vascular changes at the time of diagnosis (3). In a study in Houston, glaucoma was present in 4.8 percent of patients in comparison to 1.8 percent in a control group (37).

Incidence. Proliferative retinopathy was present in 18 percent of survivors with juvenile diabetes at 15 to 19 years duration, and in over 45 percent of survivors with 30 years or more of juvenile diabetes in studies in Boston and Cincinnati (24, 38). In general, about 7.5 percent of diabetics with retinopathy and normal vision develop visual impairment yearly, and approximately half of these become blind yearly (35). In a study in Baltimore where vision was lost in one eye, there was 84 percent loss of vision in the other eye within two years (39).

TABLE 17. AGE AT DIAGNOSIS OF DIABETES IN 847 PATIENTS WITH NEOVASCULARIZATION (40)

Age	Number	Percent of Cases
0-19	351	41
20-39	220	26
40-59	264	31
60+	12	1

TABLE 18. FIVE-YEAR VISUAL DETERIORATION FROM RETINOPATHY IN DIABETIC PATIENTS WITH RETINOPATHY AND GOOD VISION (41)

Age at Diagnosis	Number	Percent Impairment of Vision	Percent Blind
0-29	40	3.2	2.8
30-59	81	14	3.3
60+	14	32	20

Cataracts

General

Cataracts in diabetes are usually of two types. One type occurs in juvenile diabetes; it develops rapidly and is different from the cataract seen in the non-diabetic. The second type occurs in the older diabetic and is similar to that found in non-diabetics.

Statistics

One study in England reported lens opacities and cataracts in 37 percent of observations in men, and in 63 percent of observations in women (42). In juvenile diabetes, reported prevalences of cataracts have ranged from 5 to 47 percent, depending on the method of examination (12). The frequencies exceed the expected for the age in question. It is not known if cataracts occur in older diabetics beyond the expected range (43). Cataract extraction appears to be more common in the diabetic (43).

TABLE 19. FREQUENCY OF LENS OPACITIES AND CATARACTS IN 2,820 OBSERVATIONS IN 1,827 DIABETICS IN RELATION TO AGE AND SEX (42)

Age (yr)	Male (%)	Female (%)
0-19	5	0
20-29	5	9
30-39	4	14
40-49	9	29
50-59	32	53
60-69	55	73
70-79	80	84
80+	86	88

Kidney Disease

General

Two kidney lesions occurring commonly in diabetics are diabetic glomerulosclerosis and arteriolarsclerosis, both abnormalities in the walls of small vessels. It is not certain if pyelonephritis (infection of the kidney) occurs in frequency beyond that of the population at large.

Statistics

In the overall picture kidney failure accounts for about half of the deaths in the long-term juvenile diabetics and about 6 percent of deaths in the older stable type diabetic (44). With current management, about 30 diabetics per 2 million population could be expected to come to dialysis and transplantation yearly (45). This approach has been shown to extend life, but insufficient time has elapsed to estimate longevity.

Prevalence. Diabetic glomerulosclerosis has been reported present by biopsy or at autopsy in 8 to 78 percent of diabetic patients (2). Reports of arteriolarsclerosis prevalence at autopsy or by biopsy have ranged from 36 to 83 percent (2), and of pyelonephritis, from 9 to 36 percent (2). The existence of this last lesion has been questioned by some. In the older living diabetics, the prevalence of renal disease has been reported in a range of 5 to 51 percent (45).

Incidence. In studies of juvenile diabetics in Cincinnati, there was a cumulative rate for proteinuria of 38 percent at 25 years duration (38). In Boston, a frequency of 41 percent in survivors of 25 years was found (24). In the University Group Diabetes Program, adult-type diabetics were at risk of developing proteinuria (100 mg/dl) in 2.1 percent and azotemia (serum creatinine $\geq$ 1.5 mg/dl) in 4.6 percent at a median interval of 6.5 years of known diabetes (6). Long-term observations on juvenile diabetics in Cincinnati revealed that one-half had renal failure after five years of proteinuria, and that life expectancy was less than three years when renal failure had set in (45). In Boston, in 112 patients with diabetes diagnosed at an average age of 12, the mean duration of life after development of proteinuria was 4.8 years, and 2.7 years when renal failure had set in (32). In a diabetic population of all ages in England, the survival rate with proteinuria at five years was 65 percent in contrast to the expected diabetic rate of 73 percent and the non-diabetic rate of 83 percent (46).

TABLE 20. PREVALENCES OF ALBUMINURIA AT KNOWN DURATION OF JUVENILE DIABETES MELLITUS (24)

Duration of Diabetes Year	Albuminuria %
5-9	2
15-19	18
25-29	39
35-39	63

TABLE 21. MORTALITY IN DIABETIC PATIENTS WITH PROTEINURIA (46)

	Mortality, % at year	
Groups	5	10
Diabetic patients with proteinuria	35	72
Diabetic patients without proteinuria	27	54
Natural expected	17	38

TABLE 22. CAUSES OF DIABETIC MORTALITY (44)

Causes of Death	Patients	Percent	No. Diagnosed at Age <20	(%)	20+	(%)
Renal	615	9	229	(48)	386	(6)
Cardiovascular	4,613	67	132	(28)	4,481	(71)
Other	1,572	23	111	(24)	1,461	(23)
	6,800	99	472	(100)	6,328	(100)

Neuropathy

General

All peripheral nerve pathways, motor or sensory, somatic or autonomic, can be affected in diabetes. Common events are leg pain, muscle weakness, abnormalities of stomach and intestinal motility, difficulty in bladder emptying because of poor bladder muscle tone, impotence, and dizziness on standing. Absent ankle jerk is probably the most common sign found on physical examination. It is not certain to what extent the brain and spinal cord may be involved. Neuropathy can be incapacitating, especially in the long-term juvenile diabetic.

Statistics

Information on the frequency of neuropathy in diabetes is extremely variable because of the different means of measurements used by different investigators (47). In fact, prevalences of 0 to 93 percent have been reported (48). In juvenile diabetic patients with 10 or more years of known diabetes, reported prevalences have ranged from 5 to 52 percent (12). It is likely that more than 200,000 diabetics in the United States currently are suffering from neuropathic symptoms.

Infections

General

With some exceptions, infections in general probably are not more common in the controlled diabetic than in the non-diabetic. Fungus infections, particularly monilia, or *Candida albicans*, occur more frequently in diabetes, however. Urinary tract and gram negative infections have been held to be common also, but firm data are not available to substantiate this. Satisfactory control permits the diabetic to respond as does the non-diabetic to common viral and other infections encountered in general medical practice.

Statistics

In studies conducted in a large hospital in Detroit in 1966 and 1969, 11 percent of diabetics hospitalized were admitted because of infection (62). Seventy-five percent of the infections were of the lower extremity, lower respiratory tract, or upper urinary tract. The remaining infections ranged from acute cholecystitis to phlebitis. In a five-year observation period of 83 juvenile diabetics in Cincinnati, the most common infections other than viral upper respiratory or viral gastroenteric were of the skin, urologic, dental, and pulmonary (12). During the same period, 20 of the juvenile diabetics had no infections other than viral mentioned above.

TABLE 23. REPORTED PREVALENCES OF SYMPTOMS AND SIGNS OF NEUROPATHY IN DIABETES

Source	Measurement	Number of Patients	% Neuropathy
Cleveland 1953	subjective complaints	261	62
Salford, Eng. 1953	general findings	100	57
Brussels 1965	objective signs	1,175	21
Stockholm 1950	objective signs	150	49
Rochester, Minn. 1961	electromyography, objective signs	103	42
Philadelphia 1958	impotence	198	55
New York 1952	skin vessel dilatation	16	44
London 1960	abnormal valsalva maneuver	337	20
Toronto 1961	objective signs	100[1]	52
Cinn. 1965	general signs	77[1]	35
Chicago 1966	objective signs, motor conduction velocity	107[2]	10
Aarhus, Denmark 1968	motor conduction velocity	14[3]	100
London 1971	motor conduction velocity	39[3]	100
Edinburgh 1977	motor conduction velocity autonomic vascular tests	10[3]	100

[1] juvenile diabetes

[2] juvenile diabetes below age 17

[3] untreated diabetes

In urine cultures of 170 juvenile diabetics in a camp in Minnesota, only one had significant bacterial growth (63). In England, nasal carriage of staphylococcus aureus was found in 76 percent of diabetic children in contrast to 44 percent in controls, and for adult diabetics, in 43 and 34 percent, respectively (64). A study in Washington, D.C., revealed a carrier rate of staphylococcus aureus of 34 percent in diabetic patients taking insulin in contrast to 11 percent in diabetics taking oral hypoglycemic drugs and in non-diabetic subjects (65). In Boston, _Candida albicans_ was found in 35 percent of urines with glycosuria of diabetes, in contrast to 8 and 10 percent of urines without sugar, respectively, in diabetics or non-diabetics (66).

TABLE 24. INFECTIONS REQUIRING HOSPITALIZATION IN 67 DIABETIC PATIENTS (62)

Lower extremity	26
Pneumonia	14
Pyelonephritis	10
Cholecystitis	4
Viral infections	3
Perirectal abscess	2
Appendicitis	2
Carbuncle	2
Other	4

TABLE 25. INFECTIONS IN 83 JUVENILE DIABETICS, AGES 15 TO 32, DURING A FIVE-YEAR INTERVAL (EXCLUDING VIRAL RESPIRATORY AND ENTERIC INFECTIONS) (12)

	% of Patients
Skin	43
Urologic	23
Dental	19
Lung	14
Gynecologic	8
Ear	8
Enteric	6
Eye	4
Other	5
No infection	24

Diabetic Ketoacidosis, Hyperosmolar Coma, and Lactic Acidosis

General

Diabetic ketoacidosis or coma is the end stage of severely uncontrolled diabetes and can terminate fatally. Hyperglycemic coma and lactic acidosis, two other instances of acute metabolic derangement, have only been recognized in recent years. These short-term complications should be preventable and reversible.

Statistics

Diabetic ketoacidosis or coma was responsible for 14 percent of all diabetic hospitalizations in the years 1968-1973 (70). Ketoacidosis or coma occurs more frequently in the juvenile-type diabetic than in older groups. In a survey of 15 Centers in the U.S., the mortality of ketoacidosis varied from 0.7 to 19 percent and ketoacidosis accounted for approximately 10 percent of all deaths of diabetics (70). Mortalities of hyperglycemic coma and lactic acidosis were reported to range from 8 to 23 percent and from 19 to 33 percent, respectively (70).

Pregnancy

General

Pregnancy can be carried out successfully in the diabetic, but the occurrence of stillbirth, congenital malformation, and neonatal morbidity and mortality remains greater than that expected in the non-diabetic pregnancy. Pregnancy has been successful even in women with diabetic complications. In recent years, perinatal wastage and morbidity

TABLE 26. ADMISSIONS FOR KETOACIDOSIS AS A PERCENTAGE OF TOTAL DIABETIC ADMISSIONS (1969-1973) DATA FROM PROFESSIONAL ACTIVITY STUDY (PAS) (70)

Age Group (yrs)	Percent of Diabetic Admissions
0-19	65
20-34	40
35-49	13
50-64	8
65+	6
all ages	14

have decreased as improvements in diabetic control, fetal monitoring, and neonatal care have come about. Gestational diabetes is mild transient diabetes that occurs in the course of pregnancy, generally resolving after delivery.

Statistics

About one and one half million women in their child-bearing years have diabetes (67). Established diabetes is present in one to five cases per 1,000 cases of the total obstetrical population (67). Gestational diabetes is estimated to occur from 13 to 33 times per 1,000 cases. Perinatal losses in diabetic pregnancy are about five times higher than the rate expected in normal pregnancy, but survival is better than 80 percent (67). Major, fatal and multiple congenital abnormalities in the infant are reported to be at least three times the expected rate (67). The long-term

United States Public Health study in Boston reports the cumulative rate of gestational diabetes progressing to decompensated or established diabetes to be approximately 60 percent in 15 years, in contrast to the rate of 4 percent among those who had normal glucose tolerance during pregnancy (68).

TABLE 27. PERINATAL SURVIVAL IN RELATION TO STATE OF DIABETES (69)

Class	State	Number	Percent Perinatal Survival
A	Chemical diabetes	32	94
B	Diagnosis at age 20 or older, duration <10 years	181	92
C	Diagnosis age 10-19, or duration 10-19 years	212	92
D	Early angiopathy, or diagnosis before age 10	340	89
E	Pelvic vascular calcification	4	100
F	Nephropathy without pyelonephritis	79	79
R	Malignant retinopathy	22	86
TOTAL		870	90

TABLE 28. POST-DIAGNOSTIC COURSE OF CHEMICAL DIABETES (68)

Final Status[1]	No.	Percent
Decompensation[2]	64	33.0
Abnormal GTT	47	24.2
Normal GTT	83	42.8
Decompensation (10-year Life Table)	111	56 ± 8

[1] Up to 16 years post-diagnostic follow-up according to the most recent test.

[2] Two or more of the following values: fasting blood sugar, 120; post prandial, 180; post glucose, 300 mg/dl.

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Diabetes now ranks as the sixth leading cause of death in the United States (Table 29)* and is reported as the underlying cause for over 37,000 deaths annually. This compares with a rank of number 10 in 1950. If deaths due to accidents are not considered, diabetes ranks fifth as a cause of death, and if cardiovascular diseases are grouped together, diabetes would rank as the fourth leading cause of death. The death rate from diabetes increased from 16.2/100,000 population in 1950 to 19.2 in 1968 and then fell to 17.7 in 1974 (Table 30).

These data, however, seriously underestimate the contribution of diabetes to mortality because many persons with diabetes die as a result of vascular complications that may be directly or indirectly related to diabetes, which are often ascribed as the underlying cause of death. For example, Tokuhata found that diabetes was coded as the underlying cause of death in only 26% of deaths of diabetics (Table 31). Diabetes, therefore, often appears on the death certificate only as a contributory cause and does not appear in tabulations such as those in Table 29.

Multiple cause of death coding permits an alternative method of assessing the importance of diabetes as a cause of death. In 1968, diabetes was stated as the underlying cause of 38,352 deaths, but diabetes also was seen as a contributing factor in an additional 91,602 deaths. Furthermore, it has been estimated that diabetes is not recorded on the death certificate in approximately 10 percent of the deaths among diagnosed diabetics.

*Tables and Figures referred to in this section appear on pages 65-81.

Causes of Death Among Diabetics

More conditions are reported on the death certificates of those who died of diabetes than on the average death certificate. In 1968, 73.7 percent of the death certificates of those who died of diabetes mentioned three or more conditions, compared to 38.5 percent for all other deaths.

Most patients with diabetes die of cardiovascular diseases, with heart disease responsible for approximately one half of the deaths (Table 32). The age of onset of diabetes, however, has an important effect on cause of death, with some 40 percent of those with onset at under 20 years of age dying from diabetic nephropathy (Table 33). With increasing age of onset, this proportion diminishes considerably, whereas the proportion dying from cardiovascular causes increases.

The ratio of deaths attributed to vascular disease in patients with diabetes compared to the general population (Table 34) is greater, especially among those dying under 45 years of age, although the vast majority die at later ages.

Mortality in Relation to Sex and Race

Age-specific death rates between 1950 and 1974 are shown in Table 30. Rates have tended to fall slightly among those under 65 years of age; but among those aged 75 and over at the time of death, the rates have increased considerably during this period, reaching a peak between 1967-70. The reasons for the increasing death rates among the elderly are unknown.

During this period, the proportion of all deaths attributed to diabetes as an underlying cause has increased from 1.68 percent in 1950 to 1.94 percent in 1973. The proportion of deaths attributed to diabetes in females is greater than in males, and especially so for non-white females (Figure 3).

Figure 4 shows that the age-adjusted diabetes mortality rate is much greater in the non-white population, especially among non-white females. Figure 4 also shows that considerable secular increases in diabetes mortality have occurred among the non-white population; whereas among white males the rates have remained relatively stationary and in females have tended to fall in recent years.

Diabetes Mortality by Regions and States

Diabetes mortality rates vary considerably by state, from a crude death rate in 1973 of 3.9/100,000 in Alaska to 26.8 in Rhode Island. Many of these differences are attributable to differences in the age distribution of the population in various states; but the racial distribution also has an important impact, since in all states, except Alaska, the rates for non-whites exceed those of the white population (Table 35). The low rate for non-whites in Alaska is probably due to the unusual rarity of diabetes among Eskimos and Aleuts, who make up the majority of this state's non-white population.

Diabetes by Country

The United States ranks among the highest four or five countries in the world for diabetes mortality and has higher rates than Canada and most European countries (Table 36). This is also true if only the white population of the U.S. is considered.

Life Expectancy and Survivorship

Since diabetes is not always reported on the death certificate, and since only deaths with diabetes as the underlying cause are routinely tabulated, the life expectancy or survivorship of diabetics in the U.S. on a national basis has not been calculated. Estimates from clinical patients, insurance applicants and policy holders, and employees of large companies, however, all indicate a reduced life expectancy or survivorship for those with diabetes. These statistics all indicate that the excess mortality is greatest in the youngest age groups and decreases progressively with increasing age, but each of these populations may be subject to selection biases that prohibit further generalization of the findings.

Table 37 shows the likelihood of a person with diabetes surviving for given periods of time according to the age of diagnosis (±1 year) for diabetes. The table also indicates survival rates relative to those of the general population of similar age and sex. The data suggest that among diabetics who experience onset when they are under 20 years of age, there is little excessive mortality during the first 15 years of the disease, but that mortality increases thereafter.

Similar conclusions were reached by Knowles (Figure 5), who has reported on the mortality experience of children aged up to 16 years at the onset of diabetes, who have been followed for up to 40 years after the onset of diabetes.

Survivorship and Life Expectancy

Survivorship of diabetics (and survival relative to that of the general population) has been reported for patients from the Joslin Clinic (Table 37) and from Rochester, Minnesota (Table 38). Table's 37 and 38 indicate that the relative survival rate diminishes as the age of onset of diabetes increases, and in the Rochester experience, it has tended to increase in recent years. The life expectancy of diabetics has been calculated in data from the Joslin Clinic (Table 39) and from the states of Iowa and Pennsylvania (Figure 6 and Table 40), where multiple cause coding and the availability of recent estimates on the prevalence of diabetes have permitted estimation of the life expectancy of diabetics among more representative populations.

While the data from Iowa and Pennsylvania indicate a greater life expectancy for diabetics than the earlier Joslin Clinic data, they are influenced to some extent by the failure to record diabetes on death certificates in all instances, which could lead to some degree of overestimation of the years of life remaining for diabetics. These computations allow only an estimation of the expected number of years of life remaining at a given age without regard to the duration or age at the onset of diabetes.

Standardized Mortality Ratios (SMR)

A further method of comparing mortality rates among diabetics to the general population is to compare the ratio of the number of deaths among diabetics to the expected number of deaths in the population.

Based on diabetes patients first seen at the Joslin Clinic between 1930 and 1956 that were followed to 1960, the Standardized Mortality Ratio (SMR) was 1.66 for males, and 2.18 for females, with the highest ratios found in men between 20 and 39 years of age and in women aged 30-39. Among male employees of the Dupont Company, Pell and D'Alonzo found a ratio of 2.62 between actual and expected deaths, with the highest ratios among those under 45 years of age. In the adult population of Framingham, Massachusetts, Garcia and others reported that the SMR for diabetics was 2.80.

TABLE 29. DEATHS AND DEATH RATES FOR THE 10 LEADING CAUSES OF DEATH: UNITED STATES, 1974

(Rates per 100,000 estimated population)

Rank	Cause of death (Eighth Revision, International Classification of Diseases, Adapted, 1965)		Number	Rate
	All causes		1,934,388	915.1
1	Diseases of heart	390-398,402,404,410-429	738,171	349.2
2	Malignant neoplasms, including neoplasms of lymphatic and hematopoietic tissues	140-209	360,472	170.5
3	Cerebrovascular diseases	430-438	207,424	98.1
4	Accidents	E800-E949	104,622	49.5
5	Influenza and pneumonia	470-474,480-486	54,777	25.9
6	Diabetes mellitus	250	37,329	17.7
7	Cirrhosis of liver	571	33,319	15.8
8	Arteriosclerosis	440	32,239	15.3
9	Certain causes of mortality in early infancy	760-769.2,769.4-772,774-778	43,171	21.4
10	Bronchitis, emphysema and asthma	490-493	26,880	12.7

Source: Advance Report Final Mortality Statistics, 1974.
National Center for Health Statistics. Data from the national vital statistics system.
Monthly Vital Statistics Report. Vol. 24, No. 11, DHEW Publication No. (HRA) 76-1120.

TABLE 30. AGE-SPECIFIC DEATH RATES PER 100,000 POPULATION FOR DIABETES MELLITUS: UNITED STATES, 1950-1974

						AGE (In Years)						
	Total	-1	1-4	5-14	15-24	25-34	35-44	45-54	55-64	65-74	75-84	85+
1974	17.7	0.5	0.1	0.2	0.5	1.9	4.3	11.4	31.7	81.6	172.0	248.4
1973	18.2	0.5	0.1	0.2	0.6	2.0	4.6	11.8	34.1	85.4	179.7	245.9
1972	18.6	0.5	0.2	0.2	0.6	2.4	4.9	12.3	33.8	89.7	181.5	255.3
1971	18.6	0.6	0.1	0.2	0.6	2.3	5.1	12.4	35.2	89.5	182.4	248.0
1970	18.9	0.3	0.2	0.3	0.7	2.2	5.3	12.8	36.7	92.1	186.8	230.2
1969	19.1	0.3	0.1	0.2	0.7	2.5	5.4	13.1	37.1	96.7	185.9	262.0
1968	19.2	0.5	0.1	0.2	0.7	2.6	5.3	13.0	39.2	99.5	183.3	258.3
1967	17.7	0.4	0.1	0.2	0.7	2.5	4.8	12.3	36.2	94.2	169.4	234.8
1966	17.7	0.5	0.2	0.3	0.7	2.6	5.0	12.1	35.7	95.7	171.5	234.4
1965	17.1	0.5	0.2	0.3	0.7	2.6	4.7	11.9	36.1	92.6	166.4	220.0
1964	16.9	0.6	0.2	0.3	0.8	2.6	4.8	12.0	37.3	91.4	161.6	204.9
1963	17.2	0.4	0.2	0.3	0.9	2.6	5.0	12.1	37.5	95.1	165.9	206.6
1962	16.8	0.6	0.2	0.3	0.8	2.5	4.6	11.7	36.9	94.0	160.2	206.7
1961	16.4	0.3	0.2	0.3	0.7	2.7	4.7	11.3	35.9	91.4	162.9	184.2
1960	16.7	0.4	0.3	0.4	0.9	2.3	4.5	12.1	37.9	93.4	163.7	181.7
1959	15.9	0.3	0.2	0.4	0.9	2.6	3.8	11.4	37.5	89.9	154.5	158.8
1958	15.9	0.3	0.3	0.3	0.9	2.5	4.1	11.2	37.0	91.6	151.7	169.9
1957	16.0	0.3	0.3	0.4	1.2	2.6	4.5	11.2	38.0	92.5	149.8	158.1
1956	15.7	0.5	0.2	0.3	1.0	2.4	3.8	11.0	37.5	92.1	151.7	162.6
1955	15.5	0.6	0.3	0.4	1.0	2.4	3.9	10.9	37.3	91.7	150.6	163.1
1954	15.6	0.5	0.3	0.4	1.0	2.2	3.9	11.3	38.3	92.3	153.9	155.3
1953	16.3	0.5	0.3	0.4	1.2	2.4	4.1	11.7	41.7	96.2	161.7	156.4
1952	16.4	0.8	0.5	0.6	1.3	2.3	4.0	12.3	40.8	99.7	161.5	152.8
1951	16.3	0.4	0.4	0.5	1.2	2.2	3.9	12.4	42.7	99.8	161.2	151.1
1950	16.2	0.7	0.3	0.6	1.1	2.2	4.2	12.4	42.1	101.2	166.7	150.3

Source: Advance Report Final Mortality Statistics, 1974.
National Center for Health Statistics. Data from the national vital statistics system.
Monthly Vital Statistics Report. Vol. 24, No. 11, DHEW Publication No. (HRA) 76-1120.
Report of the National Commission on Diabetes Vol. III., Part I, DHEW Publication No. (NIH) 76-1021.

TABLE 31. DIABETES MELLITUS AS UNDERLYING AND CONTRIBUTORY CAUSE OF DEATH, NUMBER, RATE, AND PERCENT, BY SEX AND RACE: PENNSYLVANIA, MAY 1968 - APRIL 1969

Cause of death	Total	White male	White female	Nonwhite male	Nonwhite female
			Number		
Diabetes mellitus, total reported	10,170	3,735	5,763	227	445
Underlying cause of death	2,639	927	1,472	76	164
Contributory cause of death	7,531	2,808	4,291	151	281
			Rate per 100,000 population		
Diabetes mellitus, total reported	86.2	72.3	103.5	45.8	79.4
Underlying cause of death	22.4	17.9	26.4	15.3	29.3
Contributory cause of death	63.9	54.3	77.1	30.4	50.2
			Per cent		
Diabetes mellitus, total reported	100.0	100.0	100.0	100.0	100.0
Underlying cause of death	25.9	24.8	25.5	33.5	36.9
Contributory cause of death	74.1	75.2	74.5	66.5	63.1

Source: Tokuhata _et al._, J. Chron. Dis. 28:23, 1975.

TABLE 32. CAUSES OF DEATH IN DIABETICS APPLYING FOR LIFE INSURANCE BETWEEN 1951 AND 1970*

	NUMBER	PERCENT
All Causes	1,478	100.
Total Cardio-vascular-renal	914	61.8
Cardio-vascular	828	56.0
Heart disease	724	49.0
Cerebro-vascular	85	5.8
Other vascular	19	1.3
Renal	86	5.8
Diabetes (coma and unspecified)	115	7.8
Accidents and suicides	67	4.5
Other causes	262	17.8

*Based on 10,538 applicants observed through 1971 anniversary of application, and constituting 83,687 person-years of exposure.

Source: Goodkin *et al.*, Trans. Assoc. Life Ins. Med. Dir. Am. 58:188, 1974.

TABLE 33. CAUSE OF DEATH IN DIABETIC PATIENTS ATTENDING JOSLIN CLINIC 1956-64 AND PERCENT DUE TO CARDIOVASCULAR CAUSES AND DIABETIC NEPHROPATHY BY AGE OF ONSET OF DIABETES

Cause of Death	Age of Onset (Years of Diabetes)				
	<20 (%)	20-39 (%)	40-59 (%)	60+ (%)	All Ages (%)
All Causes	472 (100)	932 (100)	3,475 (100)	1,921 (100)	6,800 (100)
Cardiovascular	132 (27.9)	584 (62.7)	2,505 (72.1)	1,392 (72.5)	4,613 (67.8)
Renal	229	142	190	54	615 (9)
Diabetic Nephropathy	200 (42.4)	87 (9.3)	87 (2.5)	15 (0.8)	389 (5.7)
Other Renal	29	55	103	39	226
Other Causes	111	206	780	475	1,572

Source: Balodimos, M.C. *In* Joslin's Diabetes Mellitus, 11th edition, (ed: Marbel, A., White, P., Bradley, R.F., and Krall, L.P.) Chap. 17, p. 537, Lea and Febiger, Philadelphia, 1971.

TABLE 34. RELATIVE MORTALITY FROM SPECIFIED CAUSES AMONG DIABETIC PATIENTS (EXPERIENCE OF JOSLIN CLINIC ON PATIENTS OF 1950-1958 TRACED TO 1961, AGES 15-74)

	Ratio: Diabetic to General Population Death Rate*	
Cause of Death	Males	Females
Total vascular disease	2.4	3.4
Ages 15-44	12.2	19.5
Ages 45-74	2.2	3.2
Heart Disease	2.0	3.2
Cerebral vascular disease	1.8	2.0
Renal vascular	17.8	17.0
Cancer	1.5	1.6

*Basis of comparison: Vascular disease -- mortality among white persons in New England, 1949-51; cancer -- mortality among white persons in United States, 1950.

Source: Entmacher, P.S., Root, H.F., and Marks, H.H. Diabetes 13: 377, 1964.

TABLE 35. ANNUAL AGE-ADJUSTED DIABETES MORTALITY RATES PER 100,000 POPULATION BY RACE AND SEX, UNITED STATES, EACH STATE AND REGION, 1969-71

	Total	Male	Female	White	Non-White
United States	14.1	13.5	14.5	12.8	25.9
New England	13.6	13.7	13.3	13.4	21.4
Maine	13.1	12.5	13.5	13.0	39.7
New Hampshire	15.2	14.2	16.1	15.2	18.2
Vermont	11.9	12.0	11.7	11.8	36.2
Massachusetts	13.3	14.2	12.5	13.1	21.7
Rhode Island	18.2	16.8	19.1	18.1	26.2
Connecticut	12.6	12.5	12.5	12.4	20.1
Middle Atlantic	15.2	14.5	15.6	14.2	26.0
New York	14.3	14.2	14.2	13.2	26.0
New Jersey	15.6	14.5	16.3	14.5	27.9
Pennsylvania	16.4	14.8	17.4	15.7	25.1
East North Central	16.1	15.6	16.4	15.2	26.4
Ohio	17.0	16.2	17.5	16.3	25.5
Indiana	15.6	14.7	16.2	15.0	25.5
Illinois	13.3	12.9	13.6	12.3	22.5
Michigan	20.2	19.9	20.5	18.8	33.2
Wisconsin	14.4	14.4	14.4	14.2	25.6
West North Central	12.8	12.5	12.9	12.2	26.8
Minnesota	11.1	11.3	10.9	11.0	22.2
Iowa	12.1	11.4	12.7	12.1	19.8
Missouri	14.8	14.0	15.5	13.7	27.5
North Dakota	12.1	11.7	12.5	11.4	63.7
South Dakota	11.8	11.8	11.8	11.1	35.8
Nebraska	11.9	13.2	10.7	11.6	27.7
Kansas	12.7	12.8	12.5	12.3	22.7
South Atlantic	14.4	13.6	15.1	11.4	29.0
Delaware	22.0	20.5	23.4	19.9	36.9
Maryland	18.6	16.5	19.9	16.1	32.6
District Columbia	21.3	23.6	19.4	10.1	30.6
Virginia	12.4	11.7	12.9	10.0	23.6
West Virginia	13.0	10.4	15.2	12.0	34.9
North Carolina	15.4	15.0	15.7	12.1	28.7
South Carolina	19.3	17.0	21.0	14.5	32.6
Georgia	15.5	14.8	16.0	11.6	28.6
Florida	11.1	11.0	11.3	9.0	29.1

TABLE 35. ANNUAL AGE-ADJUSTED DIABETES MORTALITY RATES PER 100,000 POPULATION BY RACE AND SEX, UNITED STATES, EACH STATE AND REGION, 1969-71 (Continued)

	Total	Male	Female	White	Non-White
East South Central	14.4	13.0	15.5	11.9	26.0
Kentucky	15.1	14.4	15.6	13.9	31.8
Tennessee	12.4	11.4	13.1	10.3	24.7
Alabama	14.9	13.2	16.3	11.7	25.1
Mississippi	16.3	13.5	18.5	11.5	26.2
West South Central	14.3	12.8	15.6	12.2	27.4
Arkansas	11.9	10.1	13.5	10.2	36.4
Louisiana	21.4	18.2	24.0	15.9	36.4
Oklahoma	11.7	11.7	11.6	10.5	23.4
Texas	13.4	12.1	14.5	12.1	23.4
Mountain	11.9	12.0	11.8	11.4	25.1
Montana	12.0	13.8	10.2	11.6	26.3
Idaho	12.5	11.6	13.3	12.5	16.2
Wyoming	10.0	9.0	10.8	9.6	29.8
Colorado	9.7	8.7	10.5	9.6	15.3
New Mexico	14.9	14.5	15.3	14.0	28.2
Arizona	11.0	11.9	10.1	10.0	26.8
Utah	14.9	15.6	14.3	14.6	33.0
Nevada	14.4	14.5	14.4	13.5	32.0
Pacific	10.4	10.6	10.3	9.9	17.2
Washington	12.0	12.2	11.8	11.9	20.5
Oregon	9.7	9.6	9.7	9.5	15.8
California	10.1	10.3	9.9	9.5	17.2
Alaska	6.7	6.3	7.1	8.9	1.6
Hawaii	16.5	16.2	17.1	14.1	17.6

Source: Report of the National Commission on Diabetes. Vol. III, Part 1, DHEW Publication No. (NIH) 76-1021.

TABLE 36. MORTALITY FROM DIABETES, UNITED STATES, CANADA, AND SELECTED EUROPEAN COUNTRIES, 1957-58--1967-68

Average Annual Death Rate per 100,000*

Country	1957-58		1967-68		% Increase	
	Male	Female	Male	Female	Male	Female
United States						
White	11.2	14.2	13.1	13.6	17	-4
Non-White	13.6	25.4	19.9	31.6	46	24
Total	11.4	15.2	13.5	14.9	18	-2
Canada	9.4	11.9	11.6	12.6	23	6
Denmark	4.5	5.3	8.4	8.5	87	60
Norway	4.6	5.8	4.5	4.4	-2	-24
Sweden	7.0	8.3	10.5	10.9	50	31
Netherlands	7.5	14.1	9.1	15.1	21	7
Weighted Average	6.5	9.9	8.8	11.5	35	16
United Kingdom						
England & Wales	3.7	6.1	5.0	5.6	35	-8
Northern Ireland	4.2	5.4	5.0	6.8	19	26
Scotland	4.9	8.6	7.2	9.0	47	5
Ireland	5.1	5.6	5.9	6.9	16	23
Belgium	10.3	17.5	13.9	23.4	35	34
France	6.9	7.8	9.8	10.0	42	28
Germany, Fed. Rep.	6.6	9.3	9.0	11.6	36	25
Switzerland	7.7	9.8	12.0	14.1	56	44
Weighted Average	6.0	8.4	8.4	10.1	40	20
Italy	7.3	9.5	11.4	15.6	56	64
Spain	6.4	8.9	7.7	10.2	20	15
Portugal	6.1	5.8	7.6	8.0	25	38
Weighted Average	6.9	8.9	9.8	13.0	42	46

*Adjusted on basis of age distribution of the United States total population 1940. (Minus sign denotes decrease.)

Source: Reports of Division of Vital Statistics, National Center for Health Statistics; World Health Statistics Annuals, World Health Organization; and Demographic Yearbook, Statistical Office of the United States.

TABLE 37. PERCENTAGE OF SURVIVORS (AND PERCENTAGE RELATIVE SURVIVAL*) OF DIABETICS OF LESS THAN ONE YEAR DURATION ACCORDING TO AGE AT FIRST VISIT AT FIVE YEARLY INTERVALS THEREAFTER, BASED ON CASES FIRST SEEN AT THE JOSLIN CLINIC BETWEEN 1939-59

		Age at First Visit				
	Anniversary Years	0-19	20-39	40-59	60-79	All ages (Adjusted)
Males	5	99(100)	96(100)	90(97)	75(98)	91(99)
	10	97(98)	95(99)	76(92)	46(87)	79(94)
	15	96(98)	91(97)	59(84)	24(77)	67(89)
	20	87(89)	78(88)	42(77)	7(48)	54(75)
	25	80(83)	68(83)	30(75)	4(63)	45(76)
Females	5	97(97)	96(97)	92(97)	74(88)	90(95)
	10	95(96)	94(96)	80(89)	48(75)	79(89)
	15	95(95)	89(92)	62(78)	27(63)	68(82)
	20	86(87)	84(89)	43(64)	9(40)	55(70)
	25	82(83)	78(86)	28(55)	3(35)	48(65)

* Percent of diabetics surviving compared to the general population of Massachusetts shown in parentheses.

Source: Hirohata _et al._, Diabetes 16:875, 1967.

TABLE 38. PERCENT SURVIVORSHIP (AND PERCENT SURVIVAL RELATIVE TO THE WHITE POPULATION OF THE NORTHWEST CENTRAL STATES 1960*) ACCORDING TO YEARS FROM DIAGNOSIS AND PERIOD OF FIRST DIAGNOSIS IN DIABETICS IN ROCHESTER, MINNESOTA.

Years from Diagnosis	1945-54	1955-59	Total 1945-59
1	93 (95*)	91 (94*)	92 (94)
5	77 (88)	78 (91)	78 (90)
10	59 (79)	61 (87)	60 (85)
15	41 (68)	45 (81)	44 (78)
20	28 (59)	---	30 (69)

Source: Palumbo *et al.*, Diabetes 25:566, 1976.

TABLE 39. JOSLIN CLINIC, BOSTON, MASS., PATIENTS WITH DIABETES: REMAINING YEARS OF LIFE AT SELECTED AGES.

Attained age (years)	Remaining life years (expected)	
	Patients with diabetes[1]	U. S. white population 1949-1951
10	44.3	61.5
15	40.0	56.7
20	36.1	51.9
25	32.8	47.2
30	30.1	42.5
35	27.2	37.9
40	23.7	33.3
45	20.2	28.9
50	16.9	24.7
55	13.8	20.8
60	11.3	17.2
65	9.2	13.9
70	7.2	10.9

[1] Experience 1947 to 1951 for diabetic patients first observed 1930 to 1951. (Analysis by Metropolitan Life Insurance Company.) Excludes deaths within one week of first observation or hospital discharge.

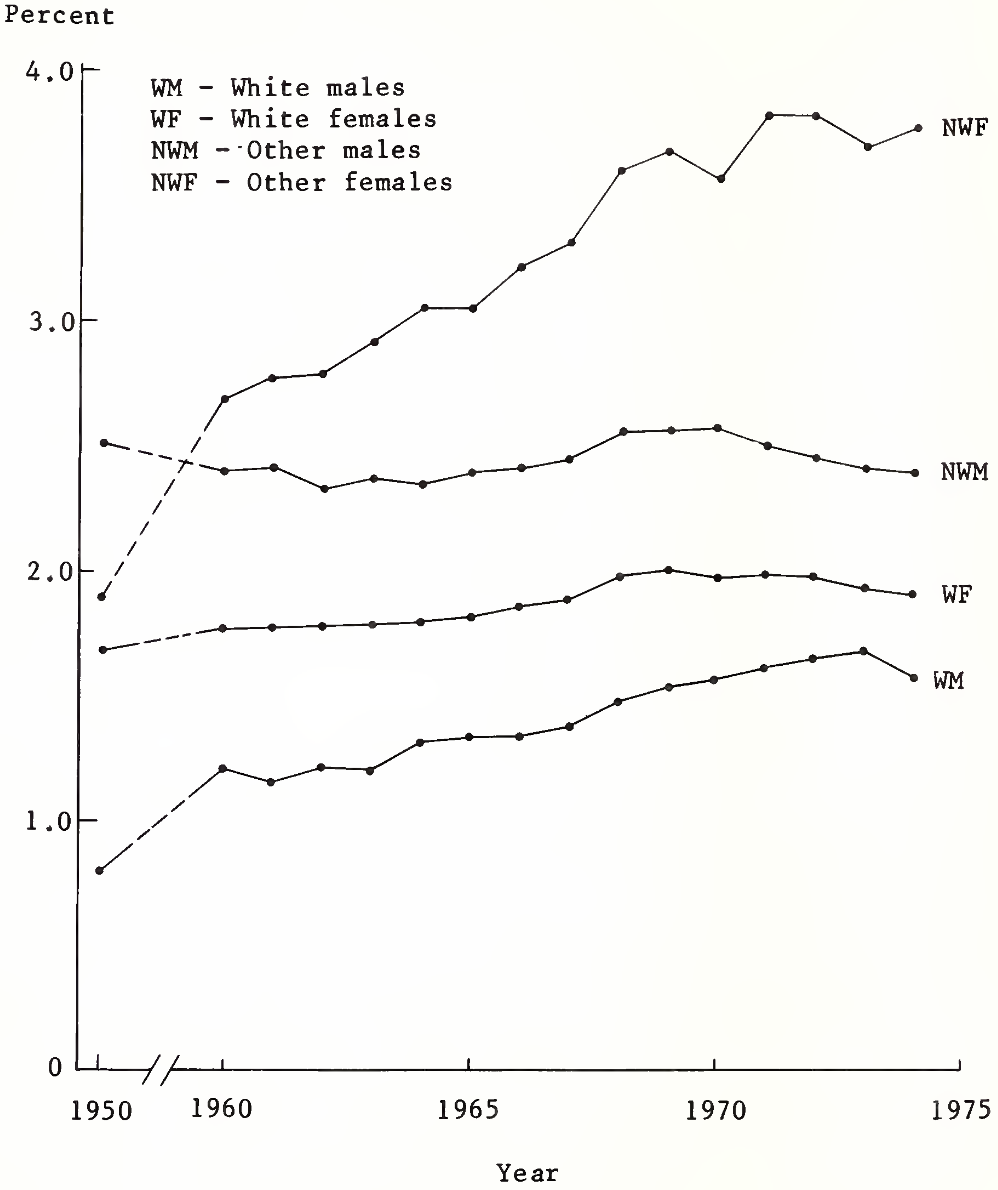
Source: Marks, H.H. New York State Journal of Medicine 61:602, 1961.

TABLE 40. COMPARISON OF LIFE EXPECTANCY AMONG DIABETICS IOWA, 1972-73, VS. PENNSYLVANIA, 1968-69.

	Expected Number of Years of Life Remaining					
Age	Iowa, 1972-73			Pennsylvania, 1968-69		
(Years)	Total	Male	Female	Total	Male	Female
0- 5	65.69	59.70	69.83	63.35	59.12	66.29
5-10	61.56	56.87	64.83	59.45	55.91	61.79
10-15	56.98	52.72	59.83	54.88	51.39	57.19
15-20	53.88	49.23	57.20	50.07	46.39	52.53
20-25	49.22	44.64	52.49	45.15	41.59	47.53
25-30	44.49	40.17	47.60	40.45	37.29	42.58
30-35	40.00	35.72	43.09	35.98	33.25	37.80
35-40	35.83	32.02	38.60	31.78	29.34	33.41
40-45	32.29	28.95	34.76	28.28	26.59	29.42
45-50	29.02	26.55	30.92	25.00	23.75	25.85
50-55	24.65	22.27	26.44	20.69	19.52	21.46
55-60	20.67	18.40	22.31	16.98	15.89	17.67
60-65	17.33	15.02	18.94	14.07	13.00	14.69
65-70	14.97	12.50	16.61	12.32	11.07	13.01
70-75	12.05	10.01	13.34	10.04	8.95	10.61
75-80	9.66	7.65	10.91	8.66	7.74	9.12
80-85	8.10	6.05	9.30			
85-90	7.50	5.31	8.66			
90-	7.54	6.23	8.17			

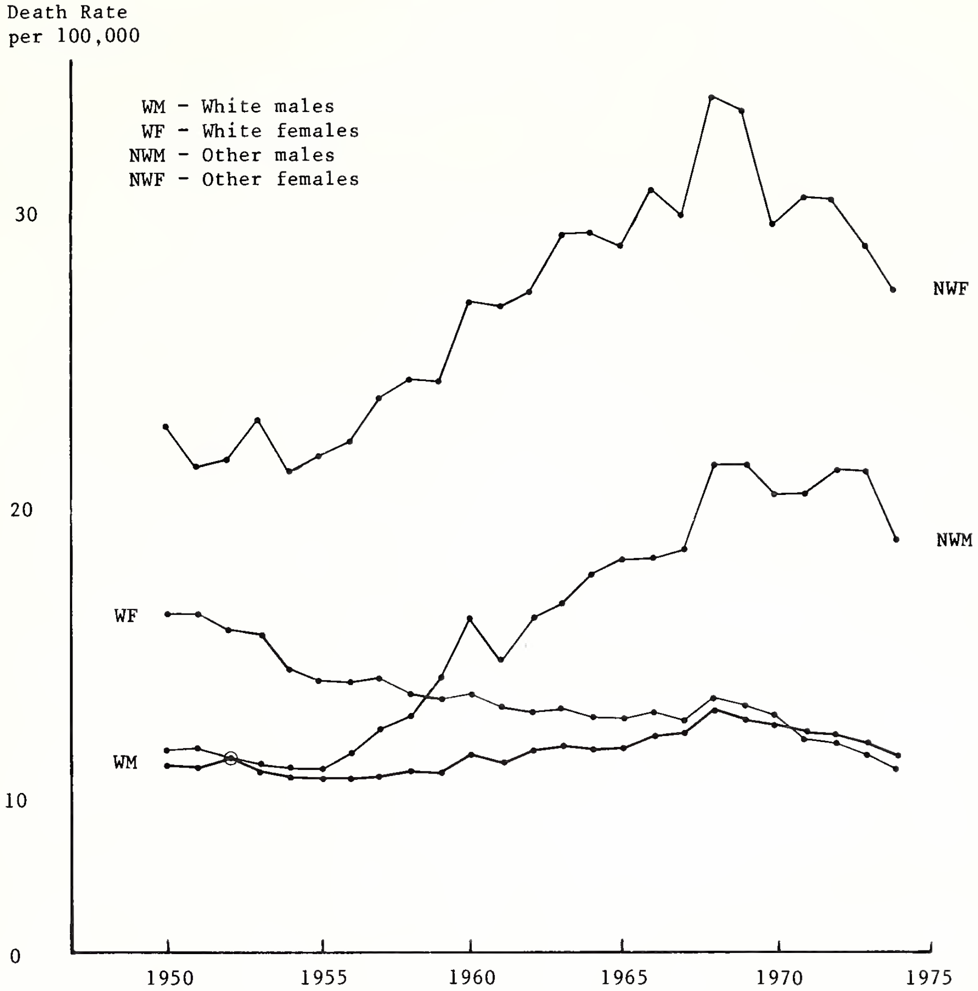
Source: Bale, G.S. and Entmacher, P.S. Diabetes 26:437, 1977.

FIGURE 3. DIABETES DEATHS AS A PERCENT OF ALL DEATHS BY SEX, RACE AND YEAR



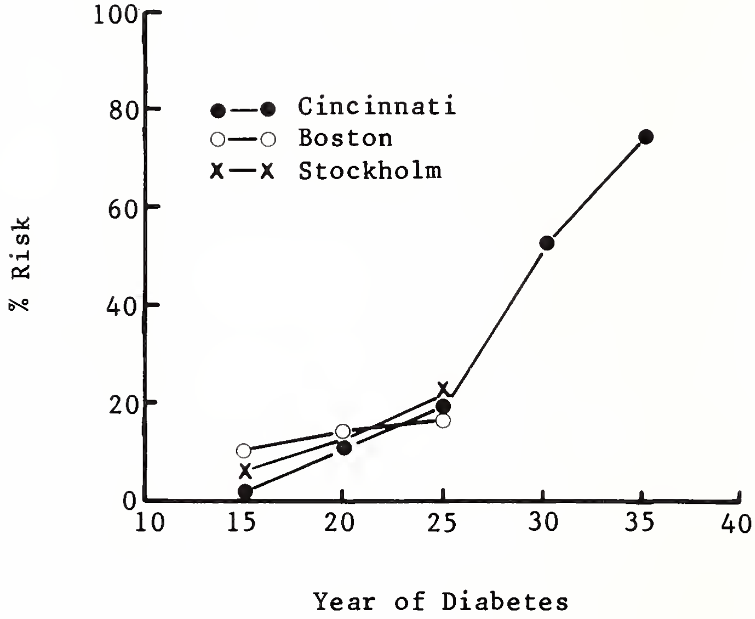
Source: Report of the National Commission on Diabetes, Vol. III, Part 1, DHEW Publication No. (NIH) 76-1021.

FIGURE 4. AGE-ADJUSTED DEATH RATES FOR DIABETES MELLITUS BY COLOR AND SEX: UNITED STATES 1950-74



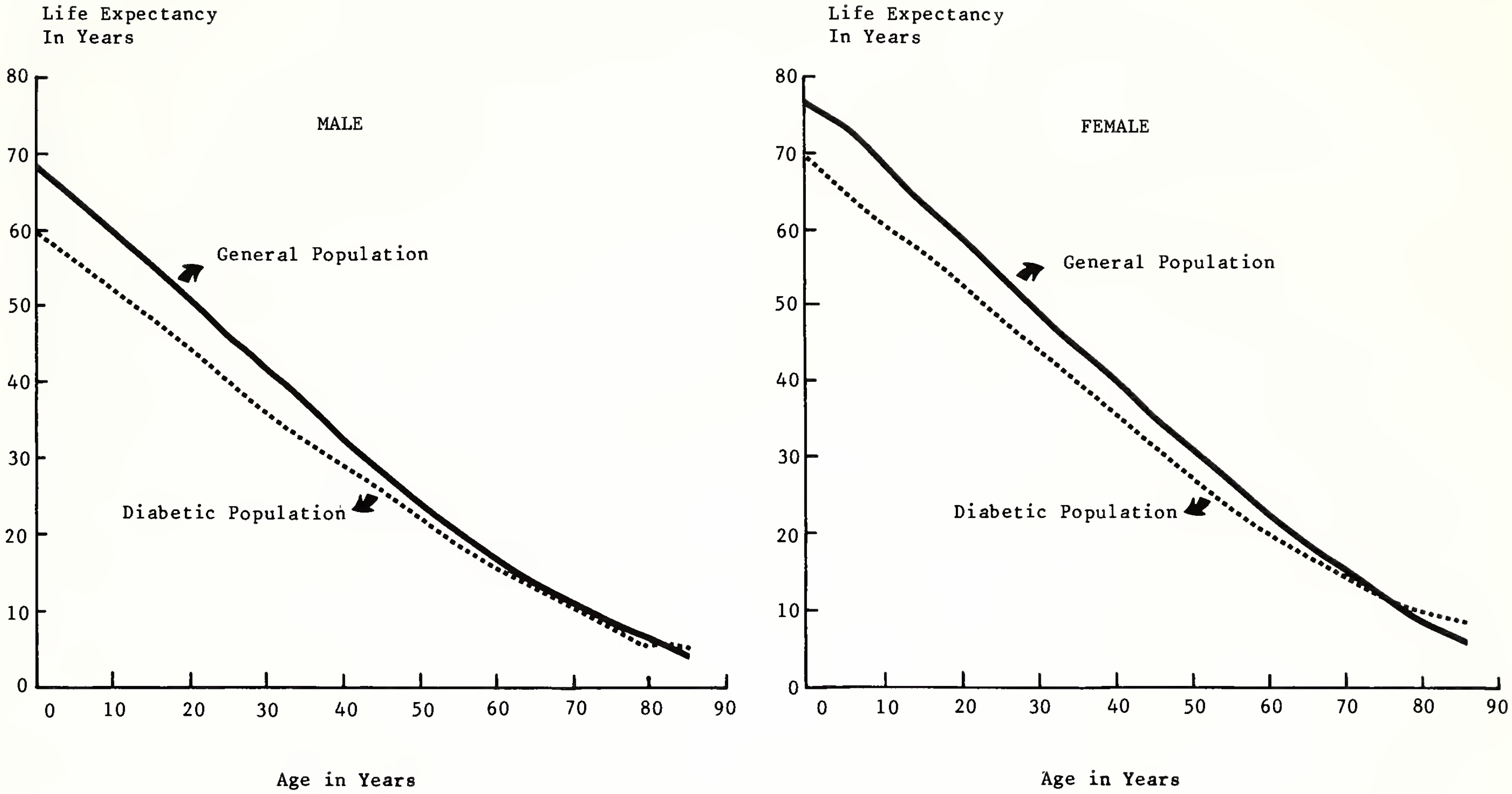
Source: Report of the National Commission on Diabetes, Vol. III, Part 1, DHEW Publication No. (NIH) 76-1021.

FIGURE 5. JUVENILE DIABETES MORTALITY CUMULATIVE RISKS



Source: Knowles, H.C. Trns. Assoc. Amer. Phys. 84:95, 1971.

FIGURE 6. LIFE EXPECTANCY BY SEX, DIABETIC POPULATION OF IOWA, 1972-73 vs GENERAL POPULATION OF IOWA, 1969-1971



Source: Bale, G.S. and Entmacher, P.S. Diabetes 26:437, 1977.

SOCIOECONOMIC COSTS[*]

It is estimated that in 1975, diabetes cost the nation 5.34 billion dollars. This sum is divided between indirect costs (Table 45), which result from loss of productivity due to morbidity and mortality, and direct costs (Table 46), which reflect expenditures for medical and related services. The direct costs attributable to complications of diabetes have been estimated at $297 million (Table 48). The indirect costs due to complications cannot be measured because of the lack of adequate data. If the costs resulting from complications are added to the overall sum, the total economic cost approaches $6 billion.

It is extremely difficult to estimate the full economic impact of diabetes. Consequently, the data that follow do not adequately reflect the gravity of the situation. Because of the nature of the disease, many of the complications, such as blindness and vascular disease, may lead to disability (and, in the case of vascular disease, to death), and the complication will be listed as causative with no reference to diabetes. Also, the impact that diabetes has as a contributing factor leading to disability or death from unrelated diseases cannot be measured.

The total economic cost of a disease is arrived at by combining the following:

A. Indirect Costs

These are defined as the losses in current productivity and earnings attributable to diabetes. These productivity and earning losses are a result of diabetic morbidity and mortality among employed persons with diabetes, diabetic women keeping house, and totally disabled diabetics. The United States lost $1.76 billion in earnings in 1975 because of diabetes. Stated another way, in 1975, diabetes consumed 164,000 otherwise productive years. Indirect costs, such as psychic cost resulting from the physical discomfort, changes in life style, and increased uncertainty suffered by patients with diabetes are not included here. These intangible costs, although a significant cost aspect of diabetes, are extremely difficult to quantify in monetary terms.

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[*] Tables and Figures referred to in this section appear on pages 89-94.

1. Morbidity. The total number of diagnosed and undiagnosed persons with diabetes was derived from the U.S. prevalence rates by age and sex (Table 41).

Of the 6.23 million persons in the United States with diabetes, about 45 percent are expected to be employed (Table 42). Sixty-five percent of diabetic males are employed, compared to 31 percent for diabetic females. For the nation as a whole, given a 4 percent unemployment rate, approximately 74 percent of the males and 40 percent of the females would be expected to be employed. The relatively low employment ratios among patients with diabetes may reflect the greater prevalence of diabetes in the older and female segments of the population, although these segments, in general, have comparatively low labor force participation rates. The prevalence of diabetes among older and female members of the population tends to reduce the economic costs of diabetes in terms of productivity losses, compared to other diseases that more frequently affect younger people.

The estimated work-years (productivity) and earnings lost by employed persons with diabetes are 31,507 and $397.75 million, respectively. Of these totals, employed males account for approximately 80 percent of the earnings lost and 69 percent of the work-years lost. Although employed females with diabetes account for 43 percent of the total number of employed diabetics, their relatively lower expected earnings reduce their share of total earnings lost to about 20 percent.

2. Mortality Among Employed Diabetics

a. Annual: Estimated work-years and earnings lost due to mortality among employed diabetics in 1975 are 5,289 and $63.4 million, respectively. The seemingly small number of deaths among employed diabetics can be explained by two factors. First, employed diabetics probably have less severe diabetes than the general diabetic population. Second, death among diabetics in general is frequently attributed to causes other than diabetes.

b. Present Value of Lifetime Earnings: The indirect economic cost to the nation of mortality from diabetes, as measured in terms of the discounted present value of lifetime earnings of persons who died in 1975, is $1.066 billion. Approximately $683 million of this loss is due to mortality among males and $382 million is due to female mortality.

3. Household Production

A large portion of the productive activity in this country is performed by housewives who receive no direct monetary remuneration. To exclude the productive activities in the household from the total sum of economic costs would result in a gross understatement of the indirect cost.

The estimates of morbidity and mortality losses among diabetic housewives indicate that 20,691 work-years and $64.9 million were lost in the household for 1975. With respect to earnings lost, losses incurred by housewives are 41 percent of the total losses incurred by all productive diabetic females. In terms of work-years lost, housewives account for 64 percent of the total work-years lost by employed diabetic females and diabetic housewives. The lower earnings loss reflects the lower monetary value placed on household activities.

4. Disabled Diabetics

These are persons who would have been employed had diabetes not interfered. Disabled diabetics are divided between those who are institutionalized and those who are not institutionalized (Tables 43 and 44). For institutionalized diabetics, the estimated number of work-years lost in 1975 is 24,700, while earnings lost amount to $235.5 million. For non-institutionalized persons with diabetes, the estimated work-year and earning losses are 81,500 and $996 million, respectively.

A summary of the indirect costs estimates is provided in Table 45. According to the estimates, 163,720 productive work-years were lost in the United States in 1975. This translates into an earnings loss of $1.758 billion, only when the annual mortality cost is included. Disabled diabetics account for a significant percentage of this figure, about 70 percent of the earnings and 63 percent of the work-year losses. Employed diabetics account for 26 percent of the earnings and 22 percent of the work-year losses, with the remainder attributed to housewives. When the $1.066 billion resulting from the discounted present value of lifetime earnings of persons who died in 1975 is included, the total indirect cost of diabetes in 1975 will be $2.824 billion.

B. Direct Costs

Estimated direct costs of morbidity due to diabetes in 1975 by type of expenditure are shown in Table 46. These costs have taken into account expenditures for prevention, detection, treatment, rehabilitation, research, training, and capital investment in medical facilities. In terms of types of services or object of medical expenditure, direct costs include amounts spent for hospital and nursing home care, physicians' and other medical professional services, drugs, medical supplies, research, training, and other non-personal services. The total direct costs of morbidity due to diabetes in 1975 are estimated at approximately $2.52 billion.

C. Cost of Complications

A National Health Interview Survey conducted in FY 1965 found that 80 percent of all the diabetics interviewed suffered from at least one other additional chronic condition, and 57 percent had three or more chronic conditions. Specifically, 21 percent of the diabetics suffered from heart disease, 17 percent from high blood pressure, and 7 percent were totally blind. With respect to hospital care expenditures, diabetics with complications (all ages) stayed three days longer per hospital visit (at an additional cost of $333) than diabetics without complications. The average length of hospital stay and the average cost per stay for diabetics with and without complications are shown in Table 47.

If it is assumed that diabetes causes other chronic conditions to be present, such as heart disease and hypertension, then the additional cost incurred from these complications should be included in the cost of diabetes. Cost estimates based on this assumption are provided for in medical care expenditures.

The total direct cost is $297 million (Table 48). The largest component of this is the cost of hospital care, $165 million. Physicians' services amount to $45.4 million; nursing home care, $36.1 million; drugs and sundries, $39.7 million; and other professional services, $9.9 million.

In view of the fact that estimates cannot be made for the total cost of complications, the partial cost was not included in the calculation of the overall economic impact of diabetes. Since the direct cost alone is almost $300 million, however, the total cost of diabetes, including the indirect cost of complications, will undoubtedly approach $6 billion. This is especially true if one considers that the under-reporting of diabetes on the death certificate results in a significant understatement of the annual impact of mortality, as well as of the present value of future earnings.

TABLE 41. PREVALENCE RATES (PER THOUSAND POPULATION) FOR DIAGNOSED AND UNDIAGNOSED DIABETICS BY AGE AND SEX IN THE UNITED STATES*

Age Group	Diagnosed Diabetics Both Sexes	Diagnosed Diabetics Male	Diagnosed Diabetics Female	Undiagnosed Diabetics**
Under 17	1.3	1.1	1.6	0.7
17-44	8.9	6.9	10.8	5.2
45-64	42.6	40.6	44.4	20.6
65 and over	78.5	60.3	91.3	26.2
All Ages	20.4	16.3	24.1	8.2

*For the purpose of this study, the same prevalence rates are applied to the sub-age groups: for instance, 40.6 per thousand prevalence rate is applied to both sub-age groups 45-54 and 55-64 for diagnosed male diabetics.

**Prevalence rates for undiagnosed diabetics are rates for both sexes. In this study, the % is divided by sexes using the weight of populations in each sex to the total population.

TABLE 42. NUMBER OF PRODUCTIVE* DIABETICS (DIAGNOSED AND UNDIAGNOSED) BY AGE, SEX, AND EMPLOYMENT STATUS IN THE UNITED STATES

(Estimated 1975)

Age Group	Employed Male	Employed Female	Housewives	Total
16-24	93,695	110,274	36,839	240,808
25-44	264,341	231,047	124,685	620,073
45-54	618,826	412,164	223,981	1,254,971
55-64	427,557	276,417	226,950	930,924
65-74	167,422	142,495	494,647	804,564
75 and over	34,885	32,346	375,943	443,174
All Ages	1,606,056	1,204,743	1,483,957	4,294,514

*Unemployed males and females excluded.

TABLE 43. NUMBER OF INSTITUTIONALIZED DIABETICS* IN THE UNITED STATES

(Estimated 1975)

Age Group	Both Sexes	Male	Female
Under 65	8,537	5,156	3,381
65-74	7,765	3,977	3,788
75 and over	8,416	4,116	4,300
All ages	24,718	13,249	11,469

*Figures represent the number of diabetics who otherwise would be employed. These figures are calculated by applying the labor force participation rates and full-employment rates to the total number of institutionalized diabetics.

TABLE 44. NUMBER OF TOTALLY DISABLED NON-INSTITUTIONALIZED DIABETICS* IN THE UNITED STATES (ESTIMATED 1975)

Age Group	Both Sexes	Male	Female
45-54	56,598	26,078	30,520
55-64	47,151	21,213	25,938
65-74	60,491	20,350	40,141
75 and over	37,757	10,520	27,237
Total	201,997	78,161	123,836

*Number of totally disabled diabetics is obtained by applying 5.6% to the number of diagnosed diabetic population 45 and over.

TABLE 45. INDIRECT COSTS: SUMMARY OF WORK-YEARS AND EARNINGS LOSS DUE TO DIABETIC MORBIDITY AND ANNUAL MORTALITY BY TYPE OF DIABETIC IN THE UNITED STATES (ESTIMATED 1975)

		Morbidity		Annual Mortality		Total	
	Number of Diabetics	Work-year Loss	Earnings Loss (in $1,000)	Work-year Loss	Earnings Loss (in $1,000)	Work-year Loss	Earnings Loss (in $1,000)
Employed Male	1,606,056	21,596	$ 318,488	3,349	$ 48,493	24,945	$366,981
Employed Female	1,204,743	9,911	79,259	1,940	14,922	11,851	94,181
Women Keeping House	1,483,957	13,410	47,573	7,281	17,338	20,691	64,911
Institutionalized Diabetics	24,718	--	--	--	--	24,718	235,489
Totally Disabled Diabetics (Non-Institutionalized)	81,515	--	--	--	--	81,515	996,394
Sub-Total	4,400,989	44,917	445,320	12,570	80,753	163,720	1,757,956
Lifetime Earnings loss from mortality							1,065,573
Total							$2,823,529

Note: Numbers are those who otherwise would be employed.

TABLE 46. ESTIMATED DIRECT COSTS OF MORBIDITY DUE TO DIABETES BY TYPE OF EXPENDITURE, UNITED STATES, 1975*

Type of Expenditure	Amount (In Millions of $)
Total	2,520
Hospital Care	1,050+
Physicians' Services	590++
Drugs	300**
Nursing Home Care	520
Other Medical Professional Services	60

*Excludes expenditures for dentists' services, eyeglasses and appliances, prepayment and administration, government and other health services, research and medical facilities construction.

+Based on days of care in short-stay hospitals.

++Cost of patient visits to physicians.

**Cost of patient visits to physicians for which drugs were prescribed.

Source: Estimated by the Statistical Bureau of the Metropolitan Life Insurance Company.

TABLE 47. AVERAGE LENGTH OF HOSPITAL STAY: DIABETICS WITH AND WITHOUT COMPLICATIONS

Age	Without Complications		With Complications	
	Average Stay (Days)	Average Cost Per Stay	Average Stay (Days)	Average Cost Per Stay
0-19	7.18	$ 775	8.13	$ 878
20-34	7.48	807	8.91	962
35-49	9.44	1,019	11.07	1,195
50-64	10.53	1,137	12.47	1,346
65 and Over	12.55	1,355	14.21	1,534
All ages	9.40	1,021	12.60	1,354

TABLE 48. DIRECT COST OF COMPLICATIONS AMONG DIABETICS IN THE UNITED STATES (ESTIMATED 1975)

	Amount (Thousands of $)
Total Direct Cost of Complications	$297,000
Hospital Care	165,000
Physician Services	45,400
Nursing Home Care	36,100
Drugs and Sundries	39,700
Other Professional Services	9,900

NEEDS FOR DATA ON DIABETES:

THE NATIONAL DIABETES DATA GROUP

The information available concerning the demography and epidemiology of diabetes, such as the information contained in this document, cannot answer many important public health questions about diabetes. The Diabetes Commission therefore recommended the establishment of a National Diabetes Data Group whose mission would be "to foster the collection, analysis, and dissemination of diabetes data related to scientific issues and public policy concerns."

The Diabetes Data Group has been established in the National Institute of Arthritis, Metabolism, and Digestive Diseases. Its functions are to:

1. Define the public health issues on diabetes to be addressed.
2. Define the data that should be collected to address these issues.
3. Foster and coordinate the collection of this data from multiple sources.
4. Seek changes in data reporting systems to more accurately identify and characterize the impact of diabetes or morbidity, mortality, and socioeconomics.
5. Promote the standardization of data collection and terminology in basic, clinical, and epidemiologic research and in surveys and detection programs.

6. Promote epidemiologic research in diabetes and the development of manpower trained in diabetes epidemiology and biostatistics.
7. Develop international liaisons to foster data collection from other countries.
8. Analyze the data, particularly as it relates to public health policy decisions.
9. Promote the timely availability of accurate, reliable data to pertinent lay, scientific, and political audiences.
10. Publish a Diabetes Source Book approximately every five years.
11. Establish a health statistics library of data relevant to diabetes to enable public access to existing and future data.
12. Sponsor cost/benefit studies on research and control program alternatives based on the results of improved data collection and analyses and timely reporting.

To fulfill the mandate of the Diabetes Commission, it is necessary first to specify what questions relating to diabetes should be addressed. For example, a summary of national needs for data on diabetes, abstracted from the report of the Commission, is presented in Table 52. Everyone concerned with the causes and impact of diabetes is invited to refer such questions to the Diabetes Data Group, which will then investigate the best way to address the submitted questions and specify the kind of data needed to answer them. Another responsibility of the Diabetes Data Group is to arrive at a consensus on the priority that should be assigned in answering the basic questions and sub-questions.

As an example, we have selected a question that recurs in conversations of diabetics, namely, what can be done about discrimination by employers against persons with diabetes? This question was chosen from many questions because:

- It is a question of major concern to those who have diabetes and their families, to those who care for them, and to those who are concerned about social policy in general.
- It is not solely a health or economic question, but one that requires an interdisciplinary approach. Data to answer this question are being collected by different agencies.
- The formulation of the question implies that persons with diabetes are in fact being discriminated against by many employers. At present, however, evidence of discrimination, only exists on a hearsay basis.
- Efforts to reduce discrimination must address the causes of the discrimination. Many of these causes are probably based on objective evidence of poor health. Some of the causes of discrimination, however, may be due to employers' conceptions or misconceptions about diabetes. What are these misconceptions and what data are needed to disprove them?

It is clear that a major effort is needed merely to specify the sub-questions implied by a basic question. It must also be a continuing effort because the basic questions as well as the sub-questions will change with changing national circumstances, and as answers to previous questions prompt new questions. This endeavor must, therefore, be both recurring and iterative.

When the sub-questions have been asked, data specification will require that additional work be done in collaboration with various data-collecting agencies. This work will only be fruitful if the questions are clearly formulated beforehand.

To ensure that no important sub-questions are omitted, a logical pattern of sub-questions must be developed. One such pattern is presented below for the question related to employer discrimination against diabetics. Others may perceive a better pattern of questioning or a better way of wording the sub-questions. The Diabetes Data Group encourages wide participation in commenting on the sub-questions and the logic of their pattern.

Having formulated the questions, it is then necessary to define the data required to answer them effectively. This definition must be done in the context of the basic analyses (Table 49). It is at this point that contact with private and public data-collecting mechanisms becomes fruitful. These contacts sometimes have data that approximate those needed. For example, submission of Table 49 to the National Center for Health Statistics revealed that the precise data desired were not available but could be approximated.

When the data needs are specified, it becomes eash for data-collecting agencies to respond to questions about the availability of data they have already collected and about the feasibility of collecting such data in the future. The tables and the logic underlying the questions also give data-collecting agencies a clear indication of the priorities for data collection.

There comes a point in developing the logical pattern of sub-questions when one may not be able to formulate the question because of a lack of knowledge. For instance, the answer to sub-question 1.2.2 below may cause some to conclude that persons with diabetes are discriminated against on the job because of unrelated health reasons. The next sub-question would then have to postulate the reasons for this discrimination. This would require research, which the Diabetes Data Group should foster through appropriate mechanisms.

Proposed sub-questions

This section presents the sub-questions derived from the basic question, "What can one do about discrimination by employers against employees with diabetes?" Sub-questions one, two, and three try to ascertain whether such discrimination does indeed exist. Under each of these sub-questions are further sub-questions that try to elucidate the causes of such discrimination, the proportion of discrimination due to each of these causes, and, where possible, the cost of eliminating or reducing the causes or the cost of mitigating the job-related effects. Figure 7 presents these questions in a more graphic form.

1. Among the employed, are the age-sex-race specific incomes of persons with and without diabetes different? If so:

1.1 Is the age-sex-race specific education of those with diabetes different from that of those without diabetes? If so, is the education of diabetics less than would be expected, given the education of their parents? If so, was this because of health-related problems?

1.2 Is the income of persons with diabetes different from that of those without diabetes when age, sex, race, and education are taken into account? If so:

1.2.1 Is this due to obvious health reasons? For example, do persons with diabetes who hold jobs miss more days from work than persons who hold jobs but do not have diabetes? If so, what are the causes of days lost from work? Could the occurrence of these causes be prevented or could the ill-effects be remedied or mitigated as far as days lost at work are concerned? How much would this cost? Cost-effectiveness and cost-benefit studies could be undertaken based on the answer to such questions.

1.2.2 Is the income of persons with diabetes different from that of those without diabetes when age, sex, race, education, and days lost from work are taken into account? If so:

1.2.2.1 Does employer knowledge that an employee has diabetes affect the employee's income? A partial answer to this question could be obtained by comparing the incomes of persons with similar, abnormal carbohydrate response curves, but with different awareness of these abnormalities.

2. Is there a difference associated with age-sex and race between the proportions of unemployed seeking work among persons with diabetes and those without diabetes? If so:

2.1 Are there differences in the number of sick days for the unemployed seeking work who have diabetes and those who do not have diabetes? What were the specific causes of the disability days? Could the illness have been prevented, remedied, or mitigated, and at what cost and for what benefit?

2.2 Is there a greater proportion of persons with diabetes than without diabetes who are unemployed and seeking work when the ages, sexes, races, and days lost from work are similar for both groups?

2.3 What are the reasons that employers give for not hiring diabetics? What data are needed to substantiate or to reject these reasons? What data are needed to mitigate these reasons? For example, employers sometimes cannot get accident insurance for persons with diabetes. What then is the increased risk of accident for persons with diabetes so that one can subsidize this insurance?

3. Is there a difference between those with and those without diabetes in the age-sex-race specific proportion of unemployed persons not seeking work? If so:

3.1 Are there more unemployed persons not seeking work who are disabled among those with diabetes than among those without, by age-sex and race? What are the causes of this disability? Was the illness underlying the disability preventable or remediable? Is the disability itself remediable or mitigable? At what cost? For what benefit?

3.2 Among the unemployed not seeking employment, are the reasons and pattern of reasons for not seeking work given by persons with diabetes different from the reasons given by those without diabetes? Research is needed to postulate "reasons for not seeking work" before a data collection is undertaken.

Proposed analyses

Each of the sub-questions must be addressed by an appropriate analysis. These proposals specify the independent, the dependent, and the control variables. For example, in sub-question 1.2.2.1, the dependent variable is the person's knowledge about his abnormal glucose tolerance curve; the dependent variable is the employee's income, and the control variable is the abnormality of the glucose tolerance curve. On the other hand, in sub-question 1.2.2, the independent variable is self-reported diabetes as contrasted to no diabetes, irrespective of the presence of abnormal glucose tolerance. The dependent variable is, again, income, and for both questions income refers to that earned by the persons, not unearned income or income earned by other household members.

Specifying the relevant income is essential to the data collecting agencies because they can then tailor their data collection to the needs of the Diabetes Data Group, even though this income information is not currently being collected. Certain control variables, such as age and education, are highly associated with differences in income. Sex and race are also sources of discrimination that are not necessarily related to diabetes, but they must also be controlled for. One must specify how each of these control variables is to be measured and grouped.

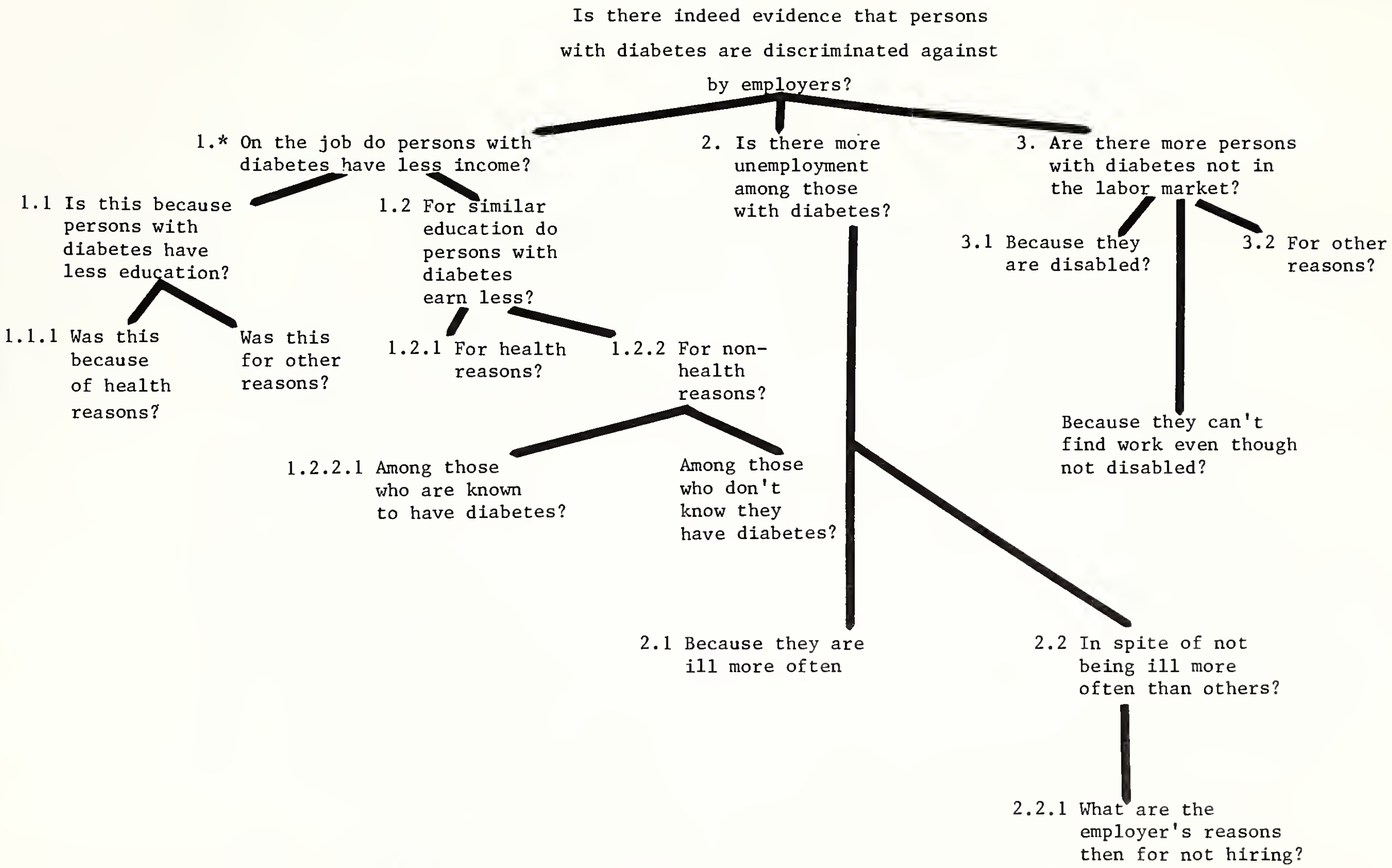
Table 49 presents the proposed analysis for sub-question 2.2 ("When age, sex, race, and days lost from work are taken into account, is there a greater proportion of persons with than without diabetes who are unemployed and seeking work?"), using data collected in 1975 by the National Center for Health Statistics. There were no data directly relevant to the question because not everybody was asked about days ill during the past year. However, everybody was asked whether he was limited in the type of job he could hold, or whether he was limited in his present job because of ill health. Therefore, we substitute "limitation of activity" for number of days ill as a control variable. Table 49 presents those with no limitation in activity.

The only group with a large enough sample size for our purposes was one comprised of white males. As we looked at the results in Table 49, we realized that the results were not interpretable without Tables 50 and 51. This illustrates the iterative process that the Diabetes Data Group will have to undertake.

Another example illustrates how the Diabetes Data Group could foster cooperation between different data collection mechanisms to acquire important data. The example concerns an investigation of the impact of leg amputation as a complication of diabetes and correlates associated with preventing leg amputation in diabetes. The correlates associated with preventing leg amputation could be investigated directly among selected groups of persons with diabetes, but the impact of the correlates on preventing leg amputation and the impact of leg amputation itself require national survey data.

A national probability survey will not efficiently identify enough amputees with diabetes to address these issues directly. Combining the data from the National Health Survey and from the selected groups of persons would result in appropriate estimates if, and only if, the critical variables are measured in the same way. By defining these crucial variables and their appropriate measurement, the Diabetes Data Group will foster cooperation across different data collection mechanisms.

FIGURE 7. QUESTIONS THAT MUST BE ANSWERED TO ADDRESS THE ISSUE "WHAT CAN WE DO ABOUT EMPLOYER DISCRIMINATION AGAINST PERSONS WITH DIABETES?"


Is there indeed evidence that persons with diabetes are discriminated against by employers?
1.* On the job do persons with diabetes have less income?
1.1 Is this because persons with diabetes have less education?
1.1.1 Was this because of health reasons?
Was this for other reasons?
1.2 For similar education do persons with diabetes earn less?
1.2.1 For health reasons?
1.2.2 For non-health reasons?
1.2.2.1 Among those who are known to have diabetes?
Among those who don't know they have diabetes?
2. Is there more unemployment among those with diabetes?
2.1 Because they are ill more often
2.2 In spite of not being ill more often than others?
2.2.1 What are the employer's reasons then for not hiring?
3. Are there more persons with diabetes not in the labor market?
3.1 Because they are disabled?
3.2 For other reasons?
Because they can't find work even though not disabled?

*Note: The number refers to the subquestions in the text.

TABLE 49. PERCENT OF UNEMPLOYED WHITE MALES WITH AND WITHOUT DIABETES WHO REPORT NO DISABILITY

Age	No Diabetes	With Diabetes
17-44	8.0%	10.2%
45-54	4.0%	8.1%
55-64	4.7%	1.4%
65-74	2.1%	2.2%
75	1.7%	0.0%

Source: 1975 National Health Interview Survey, unpublished data.

TABLE 50. PERCENT OF EMPLOYED WHITE MALES WITH AND WITHOUT DIABETES WHO REPORTED NO DISABILITY

Age	No Diabetes	With Diabetes
17-44	81.2%	83.3%
45-54	92.2%	90.6%
55-64	83.2%	91.1%
65-74	34.6%	25.5%
75	14.4%	14.0%

Source: 1975 National Health Interview Survey, unpublished data.

TABLE 51. PERCENT OF WHITE MALES NOT IN LABOR FORCE WHO REPORTED NO DISABILITY BY PRESENCE OR ABSENCE OF DIABETES

Age	No Diabetes	With Diabetes
17-44	10.8%	6.5%
45-54	3.8%	1.4%
55-64	12.2%	7.5%
65-74	63.3%	72.2%
75	84.0%	86.0%

Source: 1975 National Health Interview Survey, unpublished data.

TABLE 52. NATIONAL NEEDS FOR DATA ON DIABETES*

I. Definition, Nomenclature, and Diagnosis

Definition - lack of agreement on nomenclature; problems due to a myriad of diagnostic terms, e.g., juvenile-onset, insulin-dependent, MODY, borderline, brittle, latent, clinical, prediabetic; can we attain agreement on a classification for diabetes?

Diagnostic tests - OGTT versus other tests; which test is most suitable for population screening; can this be related to a more rigorously controlled test; how can we standardize dose and delivery; to what extent do nondiabetes-related variables affect test results and can these be quantitated?

Diagnosis - is there agreement on what are normal glucose levels; what is the age-dependent change in these levels; at what level does pathology occur; what are the problems in overdiagnosis and misdiagnosis due to inadequate testing and normal variation?

*Abstracted from the Report of the National Commission on Diabetes.

Can we develop international agreement on definition and diagnosis of diabetes to enable us to pool data from many studies?

II. Demographic and Vital Statistics Data

Mortality - what is the mortality rates of diabetics by age/sex/race; are these changing; what is the accuracy and completeness of recording of diabetes as a contributing and underlying cause of death; can we link mortality data to census data to determine geographic clustering of diabetes deaths; what will be the impact of ICD 9 on coding diabetes; what is the relative survival of diabetics versus nondiabetics; what are the causes of death of diabetics versus causes in the nondiabetic population?

Incidence and Prevalence - what are the incidence and prevalence of diabetes by age/sex/race and geographic area; are there time trends in incidence rates; is there geographic clustering of new cases; what is the number of undiagnosed diabetics; can we obtain valid comparisons of incidence and prevalence with international rates; should diabetes be reportable to the CDC; should diabetes registries be established for different types of diabetes, e.g., juvenile?

III. Etiology

Is diabetes preventable; what is the most cost-effective way to do this?

Genetics - what is the extent of familial aggregation of diabetes; do rates and the nature of complications vary in different ethnic/racial groups; is there a multifactorial inheritance; is diabetes inheritance associated with known genetic markers; are HLA and islet cell antibody screening desirable activities?

Obesity and Nutritional Factors - what is the causal contribution of obesity to adult-onset diabetes; how can we obtain amelioration of diabetes by weight reduction; is there a change in incidence rates with changing dietary habits; do we need a community-based prospective study on obesity and diabetes?

Environmental Factors - what is the role of viruses and other infectious agents in causing diabetes; are there environmental pancreatic toxins or pharmacologic agents that cause diabetes; is there a seasonal occurrence and what is its cause; why do migrant populations sometimes develop high rates of diabetes; why do rates of diabetes vary manyfold in different societies?

Pregnancy - does pregnancy predispose the mother to diabetes later in life; does the *in utero* environment of a diabetic mother predispose her offspring to diabetes; what is the relation among maternal nutrition, bodyweight, and diabetes in her offspring?

Other Risk Factors - hypertension, smoking, chromium, exercise, and cholesterol have been purported to be risk factors; do we need a diabetes "Framingham"?

What is the relation among gestational diabetes, control of glucose intolerance, and intellectual development in the offspring?

IV. Morbidity and Complications of Diabetes

What are the rates of complications among diabetics versus among the general population; can we correlate rates and severity of complications with duration and degree of glucose intolerance; do we need a clinical trial to evaluate whether control of blood glucose reduces the rate of complications of diabetes; what is the risk of development of different complications as a result of different types of diabetes?

Ocular Pathology - is the mortality of the blind diabetic greater than for persons with other causes of blindness; how many blind diabetics are there; what is the contribution of diabetes to the total public health problem of blindness; what causes the pathophysiological changes in the microvasculature of diabetics; can we develop methods for prevention of their occurrence; how much of retinopathy progresses to blindness; is there a correlation between glucose intolerance and degree of retinopathy; can eye complications be prevented by controlling blood glucose levels; can development of retinopathy be used as a marker to evaluate the efficacy of intervention methods?

Nephropathy - what are the rates of nephropathy among diabetics versus the general population; what is the contribution of diabetes to all deaths from nephropathy; how many diabetics die of nephropathy; what is the extent of reduced survival for patients with diabetic nephropathy; are there different characteristics of diabetics with and without nephropathy that lead to this pathology; can the changes in the kidney of diabetics be prevented by controlling blood glucose levels?

Macrovascular Disease - what are the rates of macrovascular disease in diabetics versus nondiabetics, including stroke, gangrene, coronary disease, atherosclerosis, etc.; how can we assess how much of the diabetic problem is due to each of these complications; how many diabetics die from cardiovascular disease secondary to diabetes; what is the contribution of diabetes to total cardiovascular deaths; how much of the excess death of diabetics is due to cardiovascular causes; why do diabetics in some racial groups have lower incidence of cardiovascular disease; why does the presence of diabetes remove the immunity of women to coronary disease; are there environmental factors that precipitate the macrovascular complications or that protect against them; what can we learn from international comparisons of rates of complications; can we prevent the cardiovascular pathology by controlling blood glucose levels?

Neuropathy - what is the extent and rate of neuropathic symptoms in diabetics; why is neuropathy more common in adult versus juvenile diabetes; what are the metabolic factors leading to the development of diabetic neuropathy; what is the extent of narcotic or other pain relief use in diabetics?

Ketoacidosis and Coma - what is the rate of these complications by age of the diabetic patient; why is the rate higher in younger diabetics; what is the rate of death due to these complications, by age and duration of diabetes; how much of hospital admissions are attributed to these diagnoses; do we need to train more EMS personnel in recognizing and treating this situation?

Pregnancy - what is the normal glucose tolerance trend throughout pregnancy; what are the best criteria for diagnosing glucose intolerance during pregnancy; what is the frequency of diabetes in the obstetrical population; what is the proper medical treatment of the pregnant diabetic; what is the maternal mortality of diabetics; does it increase with parity/age/duration of diabetes?

what is the incidence of gestational diabetes; how many women with this condition are undiagnosed; do we need more vigorous screening; how is this condition best detected during pregnancy; are the offspring at greater risk for death and malformation; how much does gestational diabetes predispose to later diabetes and should treatment be provided these women after pregnancy?

what is the fetal/perinatal death rate; what is the rate of malformations in offspring of diabetic mothers; how do these rates relate to age and duration of diabetes in the mother; can these rates be reduced with better control of maternal glucose intolerance; what is the quantitative relationship between maternal nutrition and obesity and development in the offspring?

V. Socioeconomic Data

Disability - what are the rates of disability for diabetics compared to the nondiabetic population; do diabetics have higher disability rates from nondiabetic conditions; do diabetics have lower employment rates; is this due to disability or to overt discrimination; why is there a correlation between rate of diabetes and lower income status and lower educational status?

Costs - what are the costs for health care of diabetics, according to each complication, compared to nondiabetics; how can we assess how much of diabetic costs are due to each complication; what are the indirect costs attributable to diabetes?

What is the extent and nature of other social and economic impacts of diabetes?

VI. Health Care

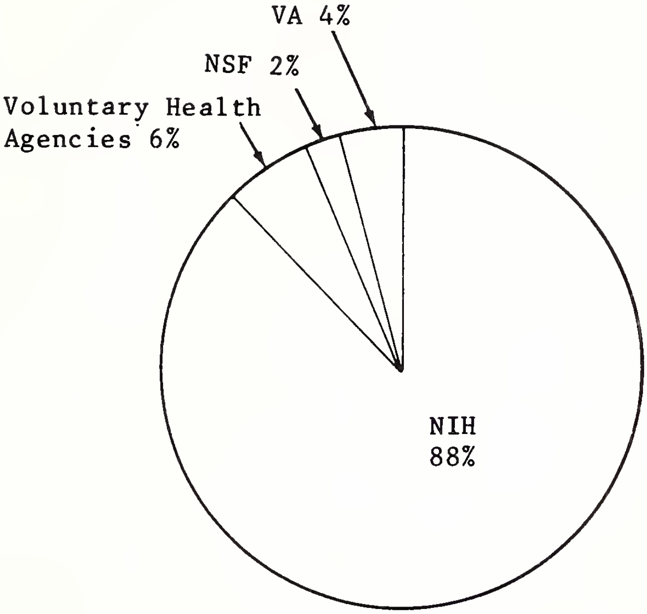
Treatment - how many diabetics are on insulin, drug therapy, diet therapy; what are the optimal treatment modes for different types of diabetes; to what extent does treatment of early diabetes protect against progression of diabetes or reverse its complications; will we have enough insulin supplies in the future to treat all insulin-dependent diabetics; problems of patient compliance?

Personnel - do we have enough physicians trained in the diagnosis and treatment of diabetes; is the medical school education curriculum in diabetes sufficient; does the M.D. out of school need continuing education in diabetes; what are our needs for home care of diabetics to prepare meals, deliver insulin, etc.; where do diabetics get counseling and education regarding their disease; is this counseling effective in terms of outcome and progression of complications; who are the most effective counselors; do we need to develop a cadre of paramedical personnel skilled in diabetic care?

FUNDING FOR DIABETES RESEARCH

FIGURE 8. PERCENT CONTRIBUTIONS OF FUNDS FOR DIABETES RESEARCH

(Total $45.7 million, F.Y. 1975)

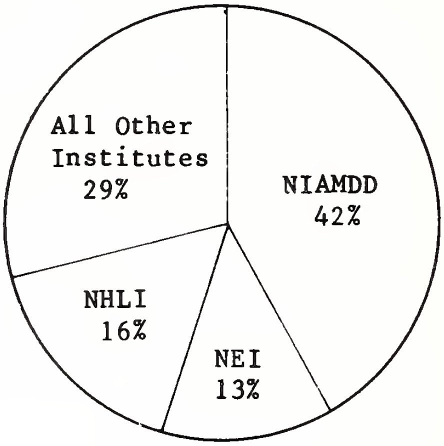


Note: Private Industry Contribution Unknown

Source: Report of the National Commission on Diabetes Vol. I, DHEW Publication No. (NIH) 76-1018

FIGURE 9. PERCENT EXTRAMURAL FUNDS FOR DIABETES RESEARCH BY NATIONAL INSTITUTES OF HEALTH

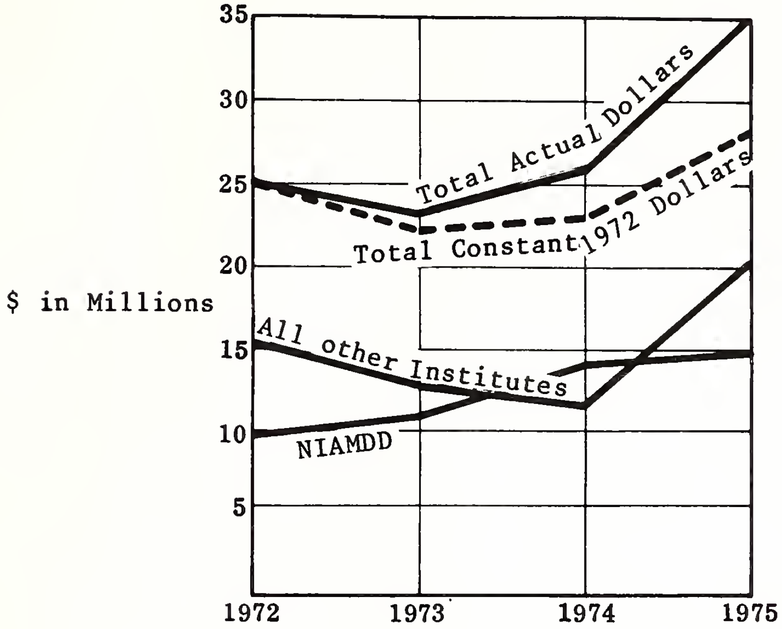
(Total: $35.2 million or 2.4% of all NIH extramural research in F.Y. 1975)



Source: Report of the National Commission on Diabetes Vol. I, DHEW Publication No. (NIH) 76-1018

FIGURE 10. NATIONAL INSTITUTES OF HEALTH EXTRAMURAL FUNDING FOR DIABETES RESEARCH

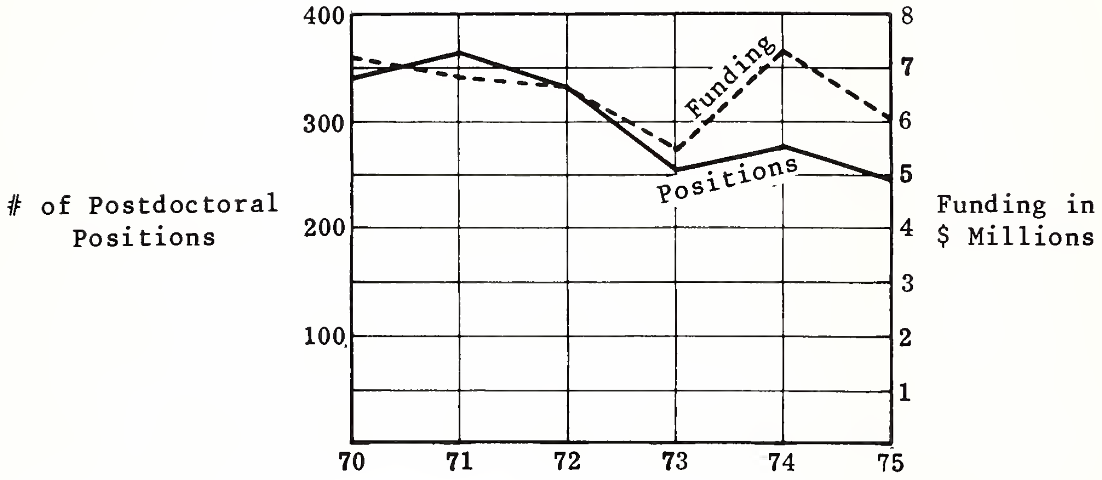
(F.Y. 1972-75)



Total NIH Institute Research Program funding rose from $1.465 million in 1972 to $2.064 million in 1975

Source: Report of the National Commission on Diabetes Vol. I, DHEW Publication No. (NIH) 76-1018

FIGURE 11. POSTDOCTORAL POSITIONS FUNDED BY NIH POSTDOCTORAL TRAINING PROGRAMS AND FUNDING
(F.Y. 1970 - 75)



Source: Report of the National Commission on Diabetes Vol. I, DHEW Publication No. (NIH) 76-1018

TABLE 53. BUDGET SUMMARY RECOMMENDATIONS BY THE NATIONAL DIABETES COMMISSION (CONSTANT F.Y. 1975 $ IN THOUSANDS)

	FY 1975	FY 1976	FY 1977 (Plan Yr.1)	FY 1978 (Plan Yr.2)	FY 1979 (Plan Yr.3)	FY 1980 (Plan Yr.4)
1. National Diabetes Advisory Board	$ 0	$ 500	$ 500	$ 500	$ 500	$ 500
2. NIH Programs	39,778	51,791	64,094	76,391	89,869	103,155
3. Research and Training Centers	0	0	8,000	12,000	20,000	20,000
4. Health Care and Control Programs	2,139	3,339	7,712	9,812	13,820	16,841
Subtotal[1]	$41,917	$55,630	$80,306	$98,703	$124,189	$140,496
5. NSF[2]	1,122	1,122	1,122	1,122	1,122	1,122
Total	$43,039	$56,752	$81,428	$99,825	$125,311	$141,618

[1] These amounts include only the diabetes share of the budget increases recommended for the General Clinical Research Centers.

[2] No specific recommendations were directed towards the National Science Foundation (NSF).

Source: Report of the National Commission on Diabetes Vol. I, DHEW Publication No. (NIH) 76-1018.

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